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REPORT OF THE TRANSITION AREA AND BALTIC AREA COMMITTEES CONCERNING THE QUESTION OF PROTECTION OF PLAICE, SALMON AND SEA-TROUT IN THE BELT SEA AND THE BALTIC

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REPORT OF THE TRANSITION AREA AND BALTIC AREA COMMITTEES CONCERNING THE QUESTION OF PROTECTION OF PLAICE, SALMON AND SEA-TROUT IN THE BELT SEA AND THE BALTIC

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Introduction

by

K. A. Andersson and **A. C. Johansen.**

At the meeting of the International Council in Stockholm in May 1927, it was resolved that before the next Council Meeting a meeting of the Transition Area and Baltic Area Committees should take place in order to discuss the scientific basis for practical measures to be taken regarding the plaice, the flounder and the salmon in the Transition and Baltic Areas, and that a report should be drawn up for the consideration of the Council. The extra meeting of the said Committees was held in Copenhagen-Hellerup on the 14th and 15th November 1927, where the following members of the Committees were present:—

Dr. Andersson, Chairman for the Baltic Area Committee.
Dr. Johansen, Chairman for the Transition Area Committee.
Professor Knudsen, Denmark.
Professor Järvi, Finland.
Dr. Fischer, Germany.
Professor Henking, Germany.
Dr. Strodtmann, Germany.
Mr. Bjerkan, Norway.
Professor Siedlecki, Poland.
Professor Pettersson, Sweden.

At the meeting it was agreed to recommend to the Council:—

I) that the following measures for the protection of the Plaice in the Belt-Sea and the Baltic should be taken:—

1) A period of closure from January 15th to April 15th regarding the plaice-fisheries in the Belt-Sea (delimited in the north by the line Hasenøre—Gniben), in the Øresund (delimited in the north by the line Gilbjerghoved—Kullen), and in the whole Baltic.

2) A size-limit of 24 cm. total length for the plaice in the Western Baltic (to the west of Gedser—Ahrenshoop), and of 22 cm. total length in the Baltic proper (east of this line).

The Western Baltic is delimited in the north by the following lines:—

a) Pontoon-bridge Sønderborg.
b) Pöls Huk — Skjoldnæs.
c) Ærø Hale — Ristinge Hale.
d) Gulstav — Kappel church.
e) Flinthorne Odde — Skelby church.

3) A prohibition of the use for the whole year of trawls and Danish seines (Snurrevaad) on the following stretches of the Western Baltic and the Baltic proper with the exception of those stretches where the depth exceeds 20 metres:—

a) In German territorial waters from Flensburg Fiord to Noord Peerd.
b) In Danish territorial waters from Flensburg Fiord to Møen's light.

The northern boundary of the Western Baltic is the same as mentioned above (2).

The boundary of the Baltic proper towards Grønsund is defined by the line Hestehoved light—Madses Klint.

c) In Swedish territorial waters from Falsterbo to Sandhammaren.

II) that an international size-limit of 35 cm. total length should be imposed for salmon and sea-trout in the whole Baltic (the Western Baltic included).

Fig. 1 shows the limits between the different waters mentioned above.

The proposals for the protection of the plaice.

The above mentioned proposals for the protection of the plaice in the Belt Sea and the Baltic or in parts of these waters arises from the fact that for a number of years a great decrease has been observed in the yield of the fishery in the Belt Sea and the Western Baltic, and that in the Baltic proper observations have been made which go to show that in the near future a great decrease in the total yield will probably take place in these waters also.

The fall in the yield of the fishery in the Belt Sea and the Western Baltic has been of an almost catastrophic nature since the year 1919, which is shown by the figures given below (Table 1). This fall in the yield must be simply ascribed to a great decrease in the size of the stock which can be proved in more than one way, as for instance by the fact that the catch per unit of fishing has declined enormously during the last decennaries at the same time as the intensity of fishing has been greatly augmented.

On account of the less intensive fishing during certain of the years of the war, there was a relatively large stock of fish in the Belt Sea at the close of the war and a fall in the yield was to be expected as a natural consequence when intensive fishing was again resumed, but Table 1 shows that the yield obtained in recent years has fallen far short of that obtained in the years prior to the war.

In the Baltic proper, intensive fishing is of recent date. Not until the year 1919 did the combined yields of the Danish, German, and Swedish fisheries exceed

Fig. 1. Limits between various waters and areas mentioned in the proposals for protection of plaice, salmon and sea-trout.

200 metric tons. But from that date the fisheries rapidly developed. In Denmark immediately after the close of the war more importance began to be attached to the fishery than formerly, and implements suitable for intensive fishing such as the Danish and otter seines were now employed in the western part of the waters. As regards Germany the fishery assumed greater dimensions from the year 1920, the otter seine (Zeesen) being employed as the most important fishing implement. Not until 1922 did Swedish fishermen begin intensive fishing operations in the Bornholm Deep, the Danish seine also in this case being employed. The Danish fishermen gradually shifted their main fishing centres eastwards to the Arcona Basin and the Bornholm Deep. As is shown in Table 2, the fishery yield rose with extraordinary rapidity, and already in 1923 the combined Danish, German, and Swedish yield reached approximately 3400 tons. The Danish and Swedish yields culminated in 1924 but the German yield continued to rise until 1926, which is the last year for which we possess full information as to the size

Table 1. Yield in Tons of the Plaice Fishery in the Belt Sea and the Western Baltic.

Year	Denmark	Germany	Total
1909	1172	996	2168
1910	1539	1160	2699
1911	1900	1117	3017
1912	3494	1229	4723
1913	2912	1175	4087
1914	1614	847	2461
1915	1121	579	1720
1916	1073	895	1968
1917	1202	1244	2446
1918	1354	1740	3094
1919	2997	1657	4654
1920	2381	1210	3591
1921	2036	911	2947
1922	1904	778	2682
1923	1624	608	2232
1924	1295	392	1687
1925	1226	419	1645
1926	1084	382	1466

of the catch. The German fishery was in the first instance carried on with greater intensity in the western part of the area between Zingst, Falster, Møen, and Rügen, but the most important fishing centres soon shifted eastwards to the Pomeranian Bay and the Bornholm Deep.

The Danish and Swedish yields had in the meantime declined greatly from 1924—1926. The maximum total yield of the plaice fishery in the Baltic observed up to now was reached in 1925, when it amounted to 4435 tons.

If we regard merely the statistics for the total yield of the plaice fishery in the Baltic proper (Table 2), we do not thereby gain any definite impression that the yield is about to culminate and that a marked decrease is to be expected. But a series of special researches which have been carried out in the Baltic by Danish, German, and Swedish investigators, in conjunction with the knowledge gained from a study of the conditions in the Belt Sea and the Western Baltic, point definitely in the direction of an imminent decrease. A very great diminution in the catch of plaice per unit of fishing (e. g. a cutter's catch per fishing day) has taken place in the Baltic; whilst at the same time a considerable increase in the growth and size of the plaice has been observed and also an improvement in its quality.

This increase in growth is an important contributory factor, during the first years after the commencement of intensive fishing, to the maintenance of the fishery yield at a comparatively high level, because there is still a comparatively large stock of small fish. If the yield could be kept at a satisfactory level and the improved quality of the fish maintained at the same time, the fishery would be progressing satisfactorily, but since the yearly renewal of the stock by natural upgrowth and migration from the Kattegat and Belt Sea are comparatively slight in the Baltic proper, we cannot in the

long run expect any great yield from the plaice fishery in these waters if suitable measures of protection are not introduced.

Table 2. Yield in Tons of the Plaice Fishery in the Baltic proper in the years 1918—1926.

Year	Denmark	Germany	Sweden	Total
1918	33	16	10	59
1919	139	57	9	205
1920	179	279	9	467
1921	278	335	15	628
1922	322	475	135	932
1923	1006	1987	419	3412
1924	2009	1517	648	4174
1925	1639	2364	432	4435
1926	1293	2450	400	4143

As mentioned above (p. 5) the Committees for the Transition Area and the Baltic Area put forward a proposal that a close season should be introduced for the period from January 15th to April 15th for the Belt Sea, the Sound, the Western Baltic and the entire Baltic proper. It is suggested that the landing of plaice in harbours or on the shores of these waters should be prohibited during the period mentioned. In proposing such a close season the intention is partly to protect the fish during a period when they are in a poor state of nutrition and can therefore only fetch a comparatively low price and partly to improve the conditions for the renewal of the stock, since the period mentioned include the plaice's most important spawning season.

A close season for plaice has up to now never been introduced for any of the countries bordering on the Baltic.

The proposal of a size limit for plaice in the Baltic is nothing new for Denmark or Germany, a size limit being already in force in each of these countries, but it signifies a raising of the present limit. As regards the Western Baltic, both Denmark and Germany impose at present a size limit of 22 cm. throughout the area to the west of the line Hyllekrog Fyr—Staber Huk, whilst in the eastern area to the east of the above mentioned line and as far as the line Gedser—Ahrenshoop the minimum for each of these countries is 21 cm. It is now proposed to raise the size limit for both areas to 24 cm. total longth.

As regards the Baltic proper, the size limit which is in force at the present time is,

for Germany 18 cm.
and for Denmark 21 cm.

It is now proposed to introduce on international size limit of 22 cm. total longth for the Baltic proper.

In Denmark, however, the ordinary Danish size limit of 25.7 cm. is enforced if

the fish are brought further into the country than the parishes bordering directly on the Western Baltic and the Baltic proper.

The Belt Sea and the Baltic is hardly ever fished by steam trawlers or the larger motor trawlers, the plaice being caught from smaller vessels with light implements such as the Danish seine, the otter seine (Zeesen) or nets, and it may consequently be assumed that by far the most of the fish caught which are below the size limit can be put out in a lively condition after capture. This is, however, less true in the case of the small fish of the 0- and the I-groups which are mainly caught at less than 20 metres' depth near the shore. In order to protect these fish therefore it is proposed to establish closed areas within the Danish and German territorial waters off the shores of the Western Baltic and within parts of the Danish, German, and Swedish territorial waters off the shores of the Baltic proper. It is suggested that fishing with trawl, otter seine, and Danish seine should be prohibited in these closed areas throughout the entire year whilst fishing with fixed gear should be permitted.

The institution of closed areas is nothing new for the countries bordering on the Baltic. In German territorial waters a prohibition of about the same scope as that proposed is already in force and for parts of the Danish territorial waters off the shores of the Kattegat and the Belt Sea a similar prohibition is enforced either throughout the entire year or for certain months of the year. The use of trawls is forbidden throughout the entire year for all parts of the Danish territorial waters, and the term trawl covers in Denmark all fishing implements which are dragged from a vessel along the bottom and are weighted with more than 20 kilograms. In Sweden all trawl fishing is prohibited in the Baltic within Swedish territorial waters.

More details in favour of the proposals for the protection of plaice in the Belt Sea and the Baltic will be found in special articles in this report by Andersson and Molander, Blegvad, Johansen, and Strodtmann.

Proposal for a size limit for salmon and sea-trout.

Already at the commencement of the activities of the International Council for the Exploration of the Sea, an investigation of the salmon and sea-trout fisheries in the Baltic was placed upon its programme. Professor Henking issued in the year 1913 a detailed account of the comprehensive investigations which had up till then been carried out[1]).

The delegates for Finland in the Council had already in 1906 pointed out that in the course of several years the salmon fishery in the Finland rivers and in the waters surrounding Finland had successively deteriorated and that similar complaints had been heard from other Baltic countries. He maintained therefore that the Council should take action to bring about an agreement between the Baltic states for the purpose of preserving the salmon stock and increasing the yield of the salmon fishery by the establishment in the states concerned of hatcheries where the greatest possible quantities of salmon might be bred.

[1]) Rapports et Procès-Verbaux Vol. XVI 1913.

The Swedish delegates pointed out on the same occasion that the salmon fishery in the Baltic had in recent years obviously been decreasing, and requested the Council to consider both the possibility of recommending a size limit for the catch and sale of marketable salmon and sea-trout and the advisability of recommending the fishery authorities of the Baltic countries to breed salmon and sea-trout in the rivers flowing into the Baltic.

In his report on the breeding, marking, and fishery of salmon and sea-trout, F. Trybom[1]) issued an account of, amongst other things, the size limits which were then in force in the various Baltic countries and proposed that the Council should as soon as possible suggest to the Baltic countries the imposition of a size limit of 50 cm. for salmon throughout the entire Baltic including the watercourses flowing into it. He based this proposal on the investigations which had been carried out on the extensive migrations of the salmon in the Baltic and on the decrease of the salmon fishery. He considered that since sea-trout did not undertake such extensive migrations as the salmon an international size limit for the former was unnecessary. Various observations now available show however that the sea-trout may also undertake long migrations (see the article by Erik M. Poulsen to this report).

Henking has shown in the above mentioned paper issued in 1913 (pp. 13—17) that the salmon fishery in the Baltic region is subjected to fluctuations which are produced by natural causes. These fluctuations and their causes have later been investigated more closely by Dr. G. Alm[2]).

We do not, however, possess sufficiently complete statistics concerning the salmon fishery for a long enough period to be in a position to draw definite conclusions about the decline of the salmon fishery in the Baltic. Still statistics from various rivers, e. g. in the middle and the north of Sweden, show that the fishery has greatly decreased for instance in the Ljungan and the Dalälv. In these rivers industrial undertakings have undoubtedly contributed very greatly to the decline of the fishery.

It should also be emphasized that the salmon fishery in the Baltic during the last twenty years have become much more intensive on account of the improved methods of capture, the increase in number of fishing vessels, and the general practice of equipping the latter with motors. This fact has also been pointed out by Professor Siedlecki in his article to this report. Nevertheless, despite this increase in the intensity of fishing, the salmon fishery in the Baltic according to the statistics available has not been able to produce so great a yield as in former days (see Alm ibid.). This indicates that the salmon stock in the Baltic is now less than formerly.

We may therefore with good reason maintain that the stock of salmon in the Baltic is greatly threatened at the present time. In the same measure as the natural conditions in the rivers are changed by the establishing of more and more numerous industrial undertakings, the possibilities for the propagation of salmon become correspondingly less. In various rivers which flow into the Baltic, the natural spawning places have doubtless been practically destroyed.

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[1]) Rapports et Procès-Verbaux Vol. XIII 1910.

[2]) Meddelanden från Kungl. Lantbruksstyrelsen Nr. 252, 1924 with an English summary.

In addition to this, the salmon is keenly pursued both in the rivers and the Baltic where as mentioned above, the fishery has become very intensive. There is thus no doubt whatever that measures are greatly needed which will safeguard the existence of the salmon stock.

The aim of such measures should be twofold, covering firstly the breeding of fish in the rivers and the hatching in hatcheries, and secondly suitable regulations for their protection.

The hatching of salmon is now carried on to a considerable extent in nearly all the Baltic countries and is even on the increase. In Sweden it will greatly increase in the next few years, and the method is being more and more adopted of rearing salmon in ponds up to the age of one or two summers before liberating them, so as to obtain satisfactory results.

Measures of protection consist of regulations prohibiting fishing during certain seasons, and in certain localities, and of certain size limits.

Prohibition of fishing for greater or lesser parts of the year is fairly common within the Baltic region. Fishing is thus in general forbidden during the spawning period.

A size limit is also in general imposed for both salmon and sea-trout.

The principal measures of protection in force in the different countries may be ascertained by consulting the special articles dealing with each country separately.

As will be clear from the foregoing, a salmon fishery of considerable extent is carried on in the Baltic, largely in international waters, and has increased in intensity more and more during recent years. The question thus arises whether the imposition of a common size-limit for salmon within the entire Baltic is needed and whether it would contribute to the preservation of the salmon stock.

It has long been known that adult salmon undertake long migrations in the Baltic. Thus salmon which have been marked off the southern shores of the Baltic have been recaptured off the coasts of northern Finland and Sweden. The marking of a large number of young salmon, 14—18 cm. in length in two rivers in the north of Sweden during the years 1924—1926 proved that salmon undertake even long migrations from their native rivers. Some of the young salmon thus marked have namely been recaptured off the coasts of Poland, Germany, and Denmark and off the southernmost coasts of Sweden. Two of the young salmon thus marked were recaptured in their native stream after a period spent in the sea. The native salmon of Finland also no doubt undertake long migrations in a southerly direction. That salmon from the rivers flowing into the southern Baltic undertake long migrations will no doubt appear from the marking experiments carried out in the Vistula. At any rate as far as the great quantity of salmon from the rivers in Finland and the north of Sweden are concerned, it appears that when emigrating to the sea they seek as a rule the southern regions of the Baltic where they remain as young salmon especially during the spring and the early summer off the shallower shores, feeding for the most part (according to O. Nordqvist[1]) and Eichelbaum[2]),

[1]) Rapports et Procès-Verbaux Vol. IX 1908.

[2]) Rapports et Procès-Verbaux Vol. XXIII 1916.

on Ammodytes. When the season of propagation approaches the mature salmon return to their native rivers. The Baltic Basin can therefore be said to possess a common salmon stock, at least to a large extent. It should therefore be to the common interest of the Baltic countries to seek to protect the salmon stock by suitable measures, thereby promoting the salmon fishery in the Baltic. Only by means of common measures for the entire Baltic can the salmon be adequately protected in the international fishing area.

The international measure which should be adopted first and foremost should, we think, aim at giving as many salmon as possible an opportunity of ascending the rivers for the purpose of spawning. As an example of the need for this it may be mentioned that in the Swedish rivers it is even sometimes impossible to obtain enough ripe salmon for the hatcheries. Most of the Baltic countries have instituted a size limit for salmon in their respective territorial waters. It may also be mentioned that since it has been found that a great number of small salmon have been captured during the spring and early summer off the southern coasts of Sweden (Skåne and Blekinge) a size limit of 50 cm. for both salmon and sea-trout has been imposed for this part of Sweden. For one part only of this coast (Malmöhus län) has the size limit been fixed at 30 cm. for the period of July 1st—December 31st.

The question then arises as to what international size limit is suitable for the purpose of protecting the salmon stock as far as possible. The imposition of a size limit is designed as a means to prevent the capture of small salmon and to give the salmon an opportunity to spawn.

As regards the size of the salmon when it for the first time in order to spawn ascends the rivers flowing into the Baltic, investigations in the different Baltic countries have shown that this as a rule does not take place until the salmon has attained a length of 50 cm. The great majority do not ascend the rivers to spawn until they have attained a length of about 70 cm. or more. We are here leaving out of account the fact that quite small male salmon sometimes become sexually mature before they migrate for the first time out to the sea. In order that the salmon may be given an opportunity to spawn the size limit should therefore not be fixed at less than 50 cm. This size limit is at the present time in force in Latvia and certain parts of Sweden.

Certain difficulties arise, however, in practice when a size limit for salmon is in force, since it is often difficult for others than experts to distinguish between salmon and sea-trout. So long as we cannot expect that those who would have to comply with such a size limit would be able to distinguish unfailingly between the two salmonids, it would be best to content ourselves with a common size limit for both. Since sea-trout are usually smaller than salmon when they begin to spawn, a size limit of 50 cm. is often too high for the former. The Baltic and Transition Area Committees have therefore considered it expedient to propose a size limit which cannot be regarded as too high for the sea-trout but yet at the same time affords a certain protection to small salmon. The Committees are therefore of the opinion that a size limit for salmon and sea-trout in the entire Baltic (see Fig. 2) should be imposed and that for the present time it should be fixed at 35 cm.

An agreement in this respect between the Baltic countries would constitute the

Fig. 2. The area for which an international size limit of 35 cm. is proposed for the salmon and sea-trout (indicated by hatching).

first step towards a rational and common regulation of the salmon fishery for the entire Baltic, both for the territorial and international waters.

Investigations should then be continued in order to explore the possibilities of adopting further measures in the future for the purpose of promoting the salmon fishery in the Baltic.

In order to ascertain the state of the salmon and sea-trout fishery in the different countries, the separate articles should be consulted which have been contributed by Alm, Henking, Järvi, Mannsfeld, Poulsen, and Siedlecki.

II. SPECIAL PAPERS CONCERNING THE PROPOSALS FOR PROTECTION OF THE PLAICE IN THE BELT SEA AND THE BALTIC

1. The plaice fishery and the plaice in the Arcona Basin and the Bornholm Area (southern Baltic) during the period 1921—1927.

By

K. A. Andersson and **Arvid R. Molander.**

a. Introduction.

Since the Swedish fishery investigations showed an abundant occurrence of plaice, flounder, and dab in the area west, north and north-east of Bornholm, a Swedish fishery was started in the autumn of 1921 in this area. This fishery did not assume large dimensions until the following year. In addition to the Swedish fishermen, both Germans and Danes have taken part in this fishery. The extent of the Swedish fishery is illustrated by the following figures:

Year	1921	15000 kg.
—	1922	133000 -
—	1923	419000 -
—	1924	648000 -
—	1925	432000 -
—	1926	400000 -

The great decrease in the amount of the catches in 1925 was due to the fact that the fishermen from Bohuslän at that time almost entirely ceased to take part in the plaice fishery in the Baltic Sea, and it has since then, as far as Sweden is concerned, been carried on almost exclusively by fishermen from Skåne and Blekinge.

Swedish fishermen use large motor boats for this fishery. As fishing gear they use the Danish seine or the otter seine.

In order to show the yield of the fishery during the different seasons we have tabulated below the figures for each month during the year 1926 from Blekinge and the east coast of Skåne.

January	9690 kg.	0.56	Swedish Kr.
February	15744 -	0.53	— -
March	19536 -	0.46	— -
April	29770 -	0.43	— -
May	56366 -	0.36	— -
June	71551 -	0.51	— -
July	37342 -	0.51	— -
August	35444 -	0.51	— -
September	27264 -	0.50	— -
October	19550 -	0.50	— -
November	18800 -	0.53	— -
December	22300 -	0.50	— -

As the table shows, the catches from January and February are the smallest and those from May and June the largest. The market price is high in January and February although the plaice is then of a poorer quality. This high price is obviously due to the scarcity during these months.

Soon however the fishermen discovered that the number of plaice available for capture began to decrease. In order to trace the changes in the stock of plaice a series of investigations were undertaken from Sweden in the area in question. The results of these investigations are collected in the following and are based chiefly on the investigations published by Arvid R. Molander (Undersökningar över Rödspätta etc. i södra Östersjön (with an English summary) and Recent Swedish researches into the fish population of the southern Baltic. — Sv. Hydrogr.-Biol. Kommissionens skrifter, ny serie, Bd. I: 1 and 2).

The material for the investigations has been collected by the research vessel "Skagerak" which has carried out trawling operations at a great number of stations in the area. The catches have been measured and otoliths collected for age determination from a great number of plaice.

The positions of the stations where the investigations took place are shown on the appended chart.

b. Changes in the stock of plaice.

When we investigate the material collected by "Skagerak" throughout the entire area of investigation including both the Bornholm Area and the Arcona Basin during the years 1921—1927, we find by comparing the catches per hour's trawling from the different years during the months August—October, that a noteworthy reduction in the size of the catches has taken place from 1921 to 1927 inclusive (Fig. 1). When we furthermore compare the catches from the various parts of this area it is clear that this reduction is particularly great on the shallow coastal banks (Figs. 2, 3) off Ystad (36—38 m.) and off Rügen (22—31 m.). Here the number of plaice decreased greatly from the year 1923. As regards the deeper parts of the Arcona Basin (42—50 m.) the catches are also here on the decline (Fig. 4) although apparently not to the same extent as on the coastal banks. This fact is, however, at least partly due to the very unequal distribution of the plaice in this area in 1921. The major part of the plaice was in that year concentrated round one single station (A 3, Fig. 5) and for this reason the average catch at a fairly large number of stations (9 st.) was relatively small. The catch at A 3, which of late years has been somewhat better than those at the other stations in the area, decreased, however, appreciably from 1921 to 1926 although not to the same extent as on the coastal banks. In the Bornholm Area the catches have decreased considerably both in deep water, 69—80 m. (Fig. 6), and in shallower water, 44—52 m., (Fig. 7 A).

When we seek to draw conclusions from the above mentioned facts as to the reduction of the stock, it must be borne in mind that the plaice are very sensitive to hydrographical conditions and tend to migrate to areas where a high temperature prevails. This fact has a certain influence on the size of the catches at the various stations. Thus

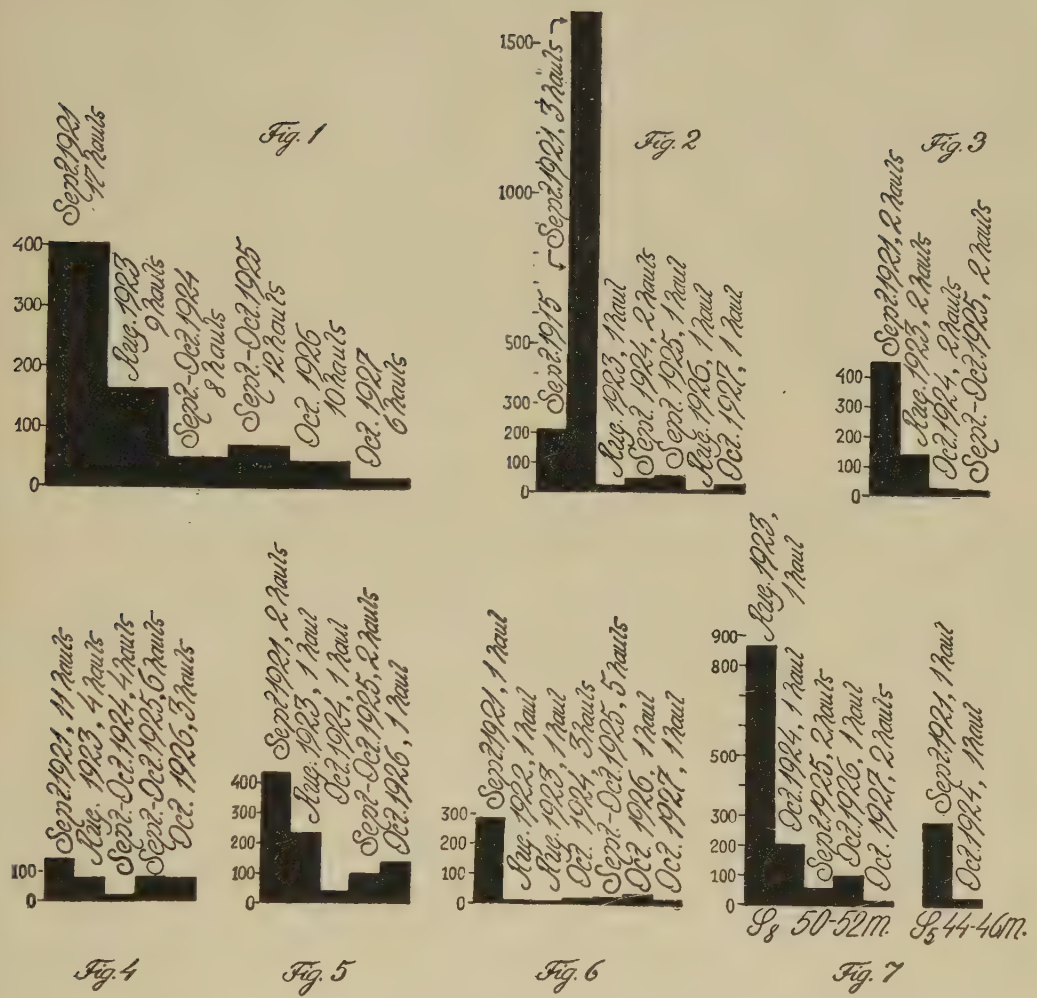

Fig. 1. Number of plaice caught per hours trawling throughout the Bornholm Area and the Arcona Basin.

Fig. 2. Number of plaice caught per hours trawling off Ystad (36—38 m.).

Fig. 3. Number of plaice caught per hours trawling off Rügen (22—31 m.).

Fig. 4. Number of plaice caught per hours trawling in the deeper parts of the Arcona Basin (42—50 m.).

Fig. 5. Number of plaice caught per hours trawling at Station A III.

Fig. 6. Number of plaice caught per hours trawling in the deeper parts of the Bornholm Area (69—80 m.).

Fig. 7. Number of plaice caught per hours trawling in the shallow parts of the Bornholm Area (44—52 m.).

every autumn (October) when an undercurrent of salt and warm water from the west flows in between Bornholm and Skåne the plaice seem to migrate westwards and appear in abundance in the region round station S 8, where they are caught in great numbers. Later in the autumn the plaice seem to disperse in a north-easterly direction with the salt and warm bottom current. However, the example given above, in which the catches from approximately the same times of the year are compared, of the reduction in the quantity of the catches — the influence of the temperature and salinity on the distribution of the plaice being duly taken into account — should on the whole give a good picture of the decrease in the stock of plaice after 1921.

These investigations show that the catches of plaice on the whole greatly decreased. This is also in accordance with the information furnished by the fishermen. This decrease can scarcely be ascribed to anything but a thinning of the stock of plaice.

c. Changes in the year classes.

The question then arises as to what can be the cause of this reduction of the stock. Since there was very little or no fishing for plaice in this area previous to 1921, and as the above mentioned fishery has been carried on very intensively from 1922, it seems probable that it is this which has caused the reduction. It is, however, also conceivable that the latter may be due to natural causes. It is therefore important first and foremost to investigate whether the year classes undergo any changes which might wholely or partly explain the reduction in the number of the plaice.

In Fig. 8 a comparison is made between the year classes as regards their distribution during the years 1922—1927. This shows that in the catches of 1922 and 1923 were found two very abundant year classes, namely those from 1914 and 1916, which in spite of their relatively great age constituted a large proportion of the stock in 1922—1923. They were still to be found in 1925 but in 1926 they seem to have disappeared. It is therefore clear that the diminution of the stock took place for the most part simultaneously with that of the two year classes. It can therefore be regarded as a certainty that these year classes were to a great extent the cause of the abundant catches when this fishery was first started and also that the thinning of the stock was at least partly caused by the number of these year classes decreasing year by year. Neither does any new year class seem to have appeared in recent years which in abundance even approximately equals those from 1914 and 1916. The IV-, V- and VI-groups which were prominent during the years 1925—1926 have not proved to be of the same importance but indicate a fairly steady, although probably small, recruiting of the stock. They have at all events not been sufficiently numerous to occur in the catches with any considerable abundance for many consecutive years. In the catches investigated in October 1927 from S 2, S 8, C 7 and Y 3, the groups 5 and 6 greatly predominate and those older than the VI-group are very poorly represented in the catches (Fig. 8).

It should be specially noted that the above mentioned rapid decrease in the quantity of the catches on the shallow coastal banks is due on the whole to the behaviour of the year classes from 1914 and 1916. When the plaice in the southern Baltic are older

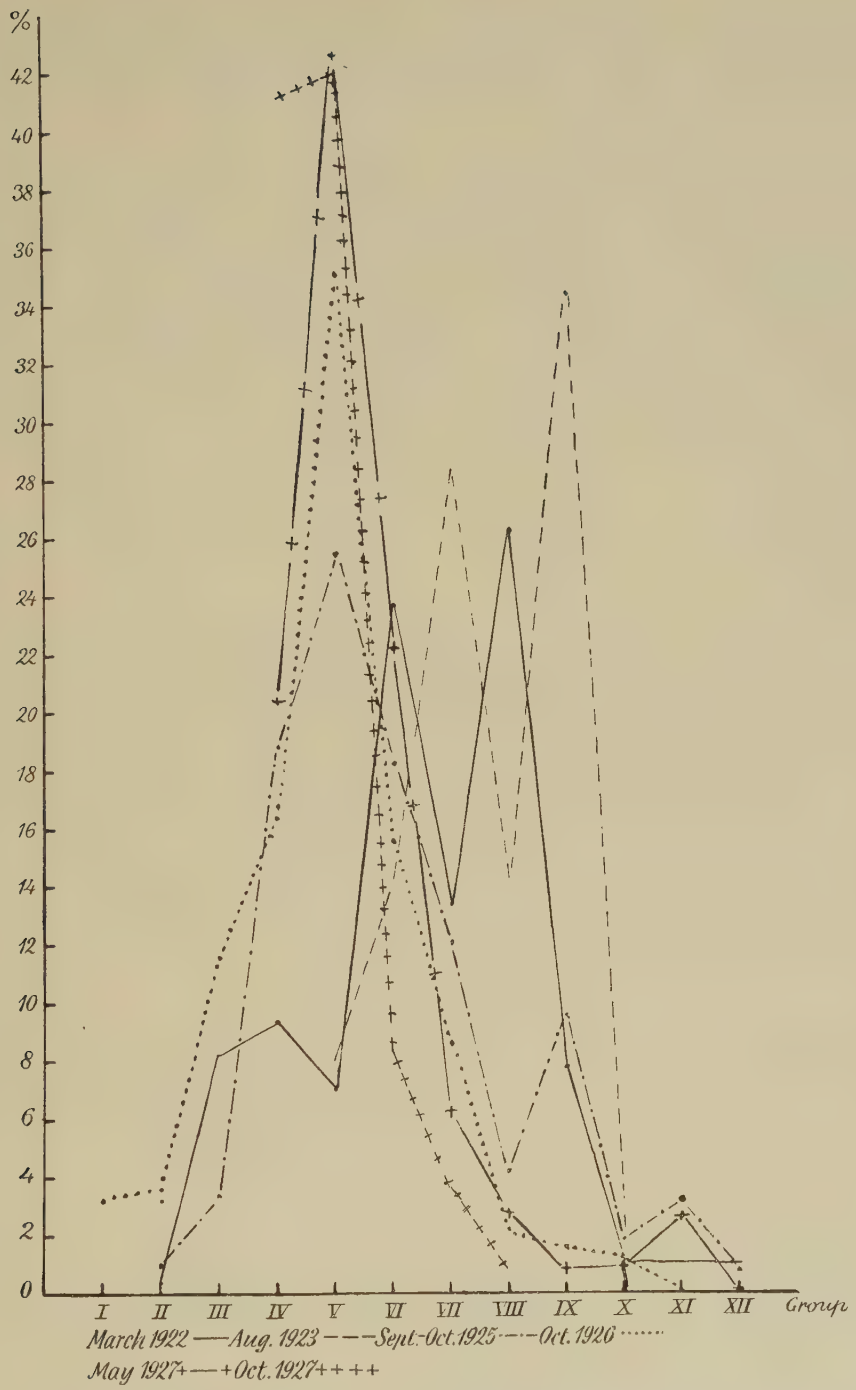

Fig. 8. Composition as regards age groups during the years 1922—1927.

they make their way to deeper regions. The above mentioned year classes have for this reason since 1922 for the greater part left the coastal banks and thereby together with the fishery caused the paucity of the stock in these regions.

d. Changes in the rate of growth of the plaice.

The thinning of the stock in recent years has also manifested itself in the changed rate of growth among the plaice. The yearly rate of growth of both males and females has greatly increased (Figs. 9, 10). At the same time as the thinning of the stock commenced in 1923 an increase in the rate of growth could be noticed (Figs. 9—14). The rate of growth has increased steadily since then and it was greatest at the most recent investigations in October 1927 (Figs. 11, 12).

The following figures giving the mean lengths of the plaice illustrate the extent of this increase.

	♀ V-group	♀ VI-group	♂ V-group	♂ VI-group
September 1921.....	23.5 cm.	25.1 cm.	20.0 cm.	23.0 cm.
September—October 1925.....	28.7 -	30.4 -	26.0 -	28.0 -
October 1927	30.4 -	33.3 -	27.9 -	32.7 -

These figures show that the increase is of great importance.

The number of plaice with abnormal otoliths is now very small. The thinning of the stock seems to have caused both that the competition for food on the whole has diminished and that the plaice are not to the same extent as formerly forced to spread over regions where the temperature and salinity are less favourable but can concentrate in localities which are hydrographically more suitable owing to the depth being greater, with the result that the rate of growth increases and becomes more steady. These circumstances have without doubt caused the increased rate of growth. The generally more favourable hydrographical conditions may also have contributed to it.

e. Measures for protecting the plaice.

It is very difficult to decide with certainty to what extent the fishery has contributed to the decrease of the stock. That the fishery is one of the factors causing the decrease is seen by the fact that the catches greatly diminished already in 1923 and 1924 when the year classes from 1914 and 1916 still constituted a considerable part of the stock.

There are also certain circumstances which show that the intensive fishery which is now carried on in the area can easily lead to real over-fishing.

No abundant year class seems to have appeared during the period 1917—1924. During this period, which may be regarded as more normal as regards the year classes, the stock has clearly been recruited fairly steadily although to a small extent. The more abnormal years, so to speak, which give rise to abundant year classes, are clearly very rare. In addition to this must be reckoned the fact that through the great decrease in the stock the number of the spawning plaice has greatly diminished, whereby propa-

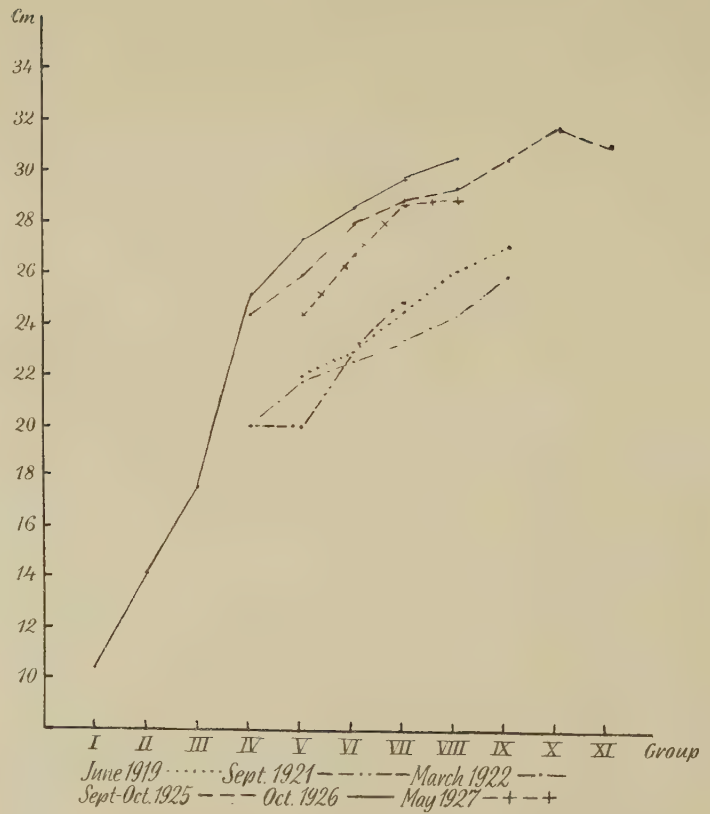

Fig. 9. Length of male plaice of the various age groups in the years 1919—1927; investigations from March to October.

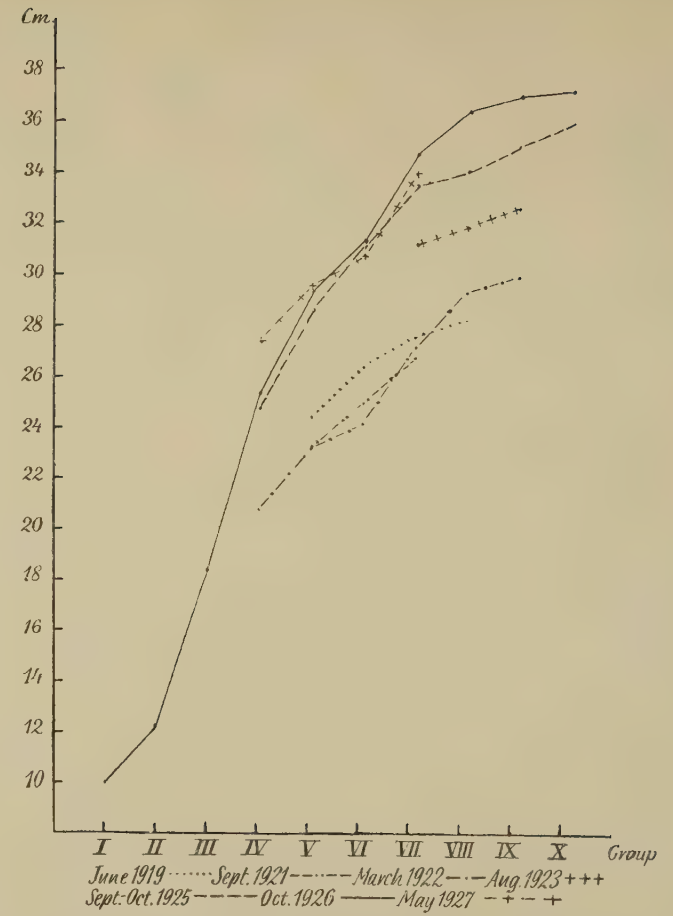

Fig. 10. Length of female plaice of the various age groups in the years 1919—1927; investigations from March to October.

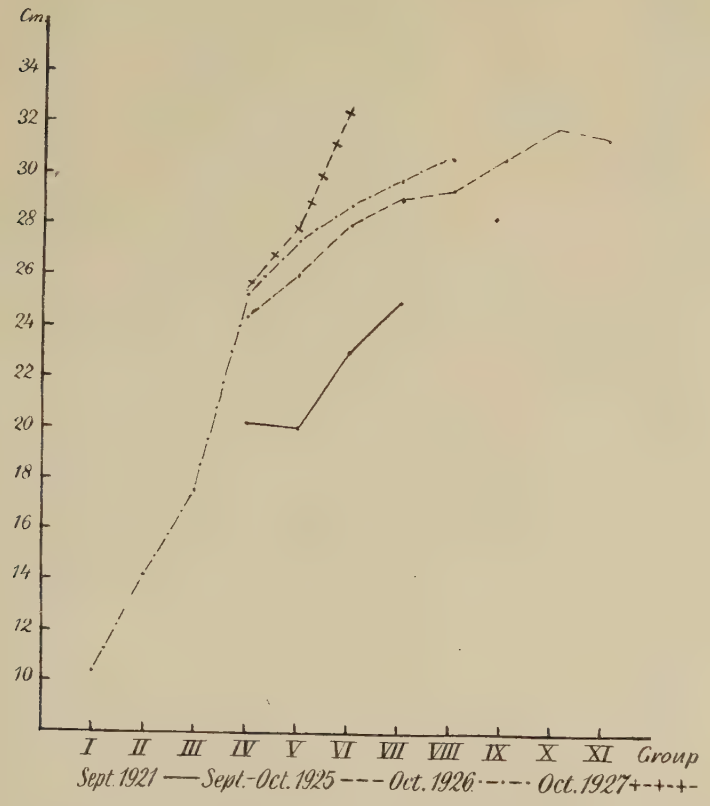

Fig. 11. Length of male plaice of the various age groups in the years 1921—1927; investigations from August to October.

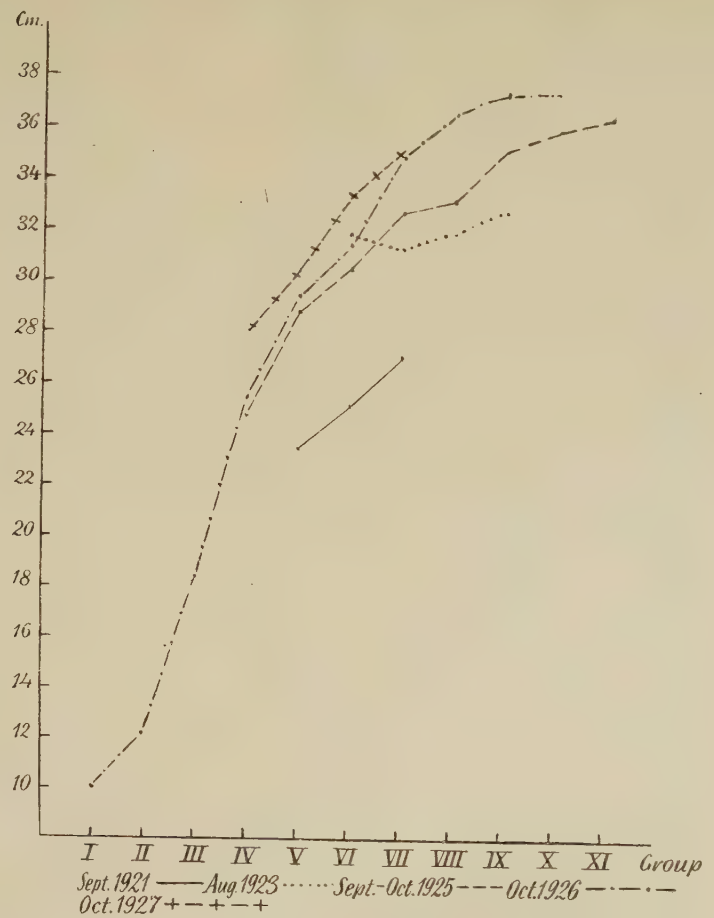

Fig. 12. Length of female plaice of the various age groups in the years 1921—1927; investigations from August to October.

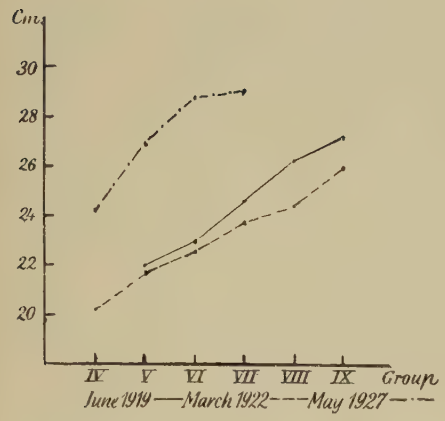

Fig. 13. Length of male plaice of the various age groups in the years 1919—1927; investigations from March to June.

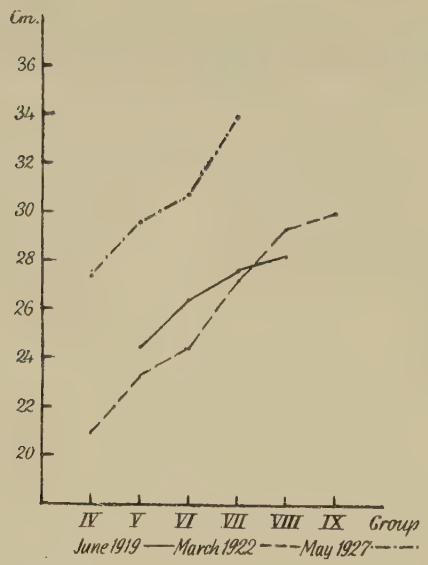

Fig. 14. Length of female plaice of the various age groups in the years 1919—1927; investigations from March to June.

gation also declines. Everything seems therefore to indicate that on the whole the stock is only recruited to a small extent and is therefore apt to become sensitive to intensive fishing. The fact must also be taken into account that the area of distribution of the plaice in the Baltic is rather small.

The great increase in the rate of growth of the plaice is of especial importance. Experience proves that such an increase is soon followed by a further great decrease in the stock. It can therefore be considered as the first warning that over-fishing is imminent. Prudence therefore demands that measures of protection should be adopted in good time in order to avoid depletion.

Since thus, as we have endeavoured to show, the recruiting of plaice in the Baltic mostly seems to be poor the logical consequence would seem to be that first and foremost measures should be taken with a view to protecting propagation. As spawning chiefly takes place during the first months of the year it seems that the prohibition of fishing for plaice during the period January 15th to April 15th would be fully justified.

During this period also the plaice are very thin and of little value. A restriction of the fishing during the spawning period would without doubt create better possibilities for the renewal of the stock and would at the same time protect it to some extent. Such a close season would be of importance also from another point of view.

The plaice would thereby as mentioned be protected during their best spawning period, whereas the flounder and dab would not be protected during their spawning periods which are March-May and May-July respectively. The more valuable plaice would thus be given a better chance of competing successfully for food with the two

other species of fish. The proposed period of closure can thus be expected to have a favourable influence on the stock of flatfish in general.

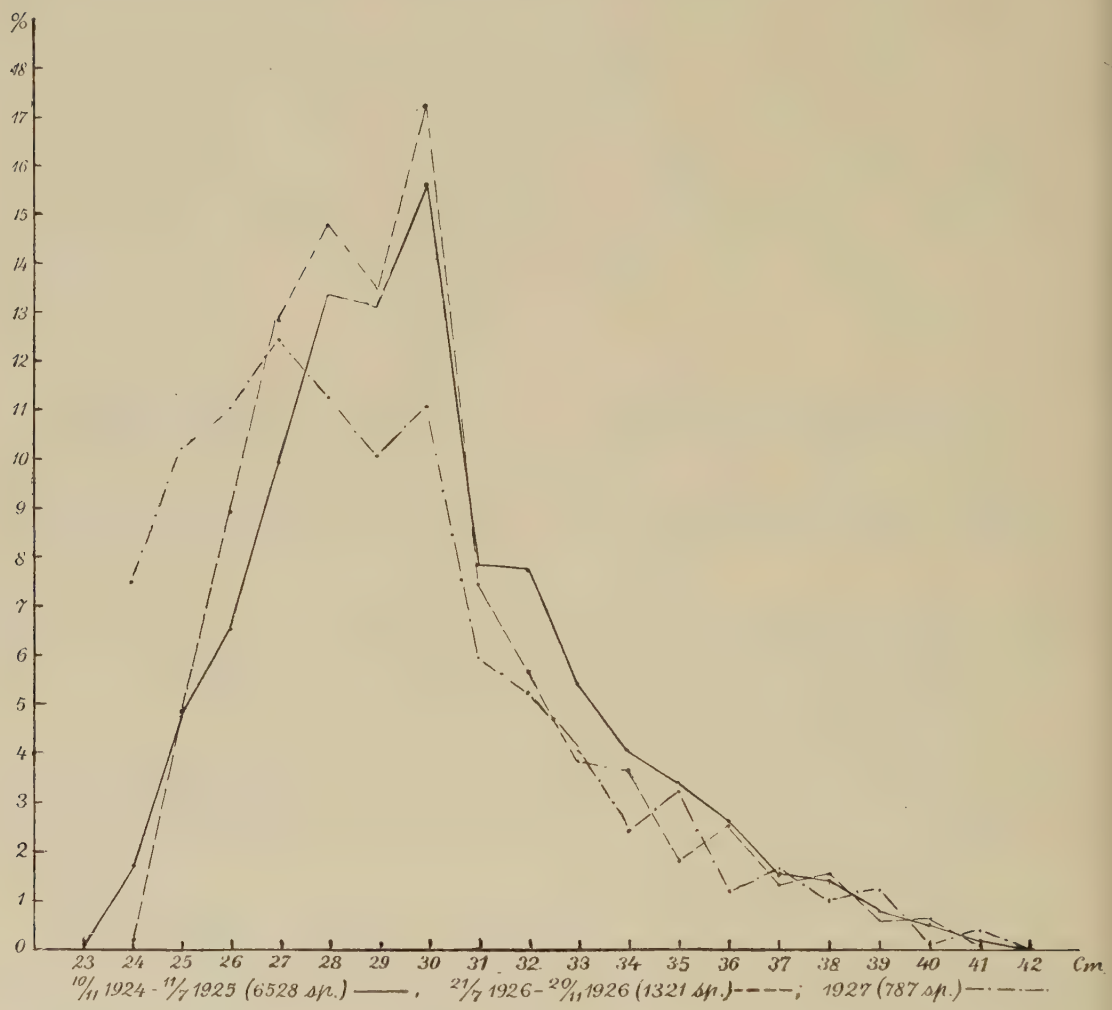

Fig. 15. Size composition of plaice taken with the Danish seine from an ordinary fisher boat.

Since the plaice in the Baltic, the Belt Sea, and the southern Kattegat possess fairly similar characteristics, it is clearly desirable that the closure should cover the entire area of distribution. For practical reasons it does not seem possible at the present moment to put into operation the closure of the Kattegat and the proposal is therefore only concerned with a close time for the Baltic and the sounds between the Kattegat and the Baltic. Large and important spawning places would thus also be protected.

The imposition of a minimum size for plaice may also within certain areas be necessary for the protection of the stock.

It must, however, be emphasized that Swedish fishermen catch only very few plaice

below the minimum size. During the years 1924 to 1927 samples of the catches landed from a boat, which used the ordinary Danish seine, have been measured at different times of the year. The measurements have shown that the bulk of the captured plaice had a length of 25—32 cm. The smallest were 23 to 24 cm. and only very few were so small (Fig. 15). But since some plaice below the minimum are caught in other parts of the Baltic plaice areas the institution of a minimum would serve to protect the stock of plaice. A minimum of 22 cm. would appear to be reasonable for the Bornholm Area and the Arcona Basin.

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2. On the Influence of the Fishery upon the Stock of Plaice in the Baltic proper

by

H. Blegvad.

a. Has the Baltic proper its own stock of plaice?

Whereas in former times opinions on this question have been very divided, investigations in recent years have contributed substantially to our enlightenment on this very subject. C. G. Joh. Petersen (11, 12 and 13) was the first to advance the theory that the plaice stock in the Baltic proper was presumably renewed by an immigration from the Kattegat and Belt Sea; he was, however, quite aware that other possibilities might be envisaged of explaining the strikingly small quantity of plaice of the 0-Group which investigators had succeeded in finding off the shores of the Baltic proper. After A. C. Johansen (5) in 1908 had found a considerable number of plaice larvae, some being freshly hatched, as far east as Bornholm Deep and Stolpe Bank, and in 1907 a fairly numerous 0-group in deep water, this immigration theory had to be abandoned. Dr. Petersen himself relinquished this hypothesis in favour of that put forward by Dr. Johansen. However, even if Dr. Johansen is right in maintaining that the Baltic proper has its own indigenous stock of plaice, his theory that the young bottom stages live for the most part at depths between 10 and 40 metres is open to doubt. The young bottom stages are undoubtedly found chiefly in the Baltic also in quite shallow water close inshore, at any rate during their first summer (H. Blegvad (1)).

The investigations carried out in 1926 and 1927 have completely confirmed this fact. Whilst in 1925 we captured 272 plaice of the 0-group off the shores of the Baltic with a hand push net alone, two men working for 7 hours in all, in 1926 we took 60 in 8 hours, but in 1927 120 in 6 hours. Moreover, Dr. Johansen's coastal investigations with fine-meshed young fish trawl in 1927 revealed a stock of 0-group off the coasts of Sealand-Møen-Falster which was in places very numerous. Off the coasts of Bornholm, the density of the plaice of the 0-group is not so great, as will be seen in the table below, which gives the average catch per half hour's work of two men with a hand push net.

Table 1.

	Coasts of Bornholm	Coasts of Sealand-Møen-Falster
1925	4.1	30.3
1926	1.2	4.8
1927	9.2	19.3

It is clear from this table that the plaice fry was comparatively less numerous off the Danish Baltic coasts in 1926 than in 1925 and 1927. I have shown in my paper mentioned above (1) that such fluctuations in the frequency of the 0-group have taken

place to a pronounced extent also in former years, and that previous investigators have more often than not had the singular misfortune to seek most eagerly for the 0-group off the Baltic coasts in those years when the plaice fry has been unusually scanty.

Dr. A. C. Johansen has calculated (5) that in May 1908 there were at least 900 millions of plaice larvae in the Baltic proper. Contrary to Reibisch's (17) theory that adult plaice immigrate from the Kattegat and the western Baltic into the Baltic proper, he states (7) amongst other things that marking experiments in the Baltic have revealed no more marked tendency for the plaice to migrate eastwards than westwards. On the other hand it cannot be denied that the influx of salt bottom water from the west may be assumed to carry a number of eggs and larvae into the Baltic proper. Since, however, as has been mentioned, both newly hatched pelagic larvae and bottom stages of the 0-group have been shown to be present near the coasts in large quantities, and seeing that the plaice in the Baltic proper are always on an average smaller than those of the corresponding age groups in adjoining waters, it can be stated that there is no valid reason for assuming an immigration on a large scale into the Baltic proper. We can therefore for all practical purposes regard the stock of plaice in the waters as indigenous.

b. The intensity of fishing.

The Danish plaice fishery in the Baltic proper was formerly, as is well known, of practically no importance. The reason for this was not that the stock was too scanty but that the quality was too poor for the plaice to be marketed without difficulty. As has often been proved by Danish, Swedish, and German investigators an accumulated ("angesammelter") stock of comparatively very old ("überaltete"), small, and slowly growing individuals constituted the Baltic plaice. German fishermen, however, under the pressure of the food scarcity during the war and immediately subsequent to it started an intensive fishery for plaice in the Baltic proper. Danish fishermen started operations in 1919 with the Danish seine in the western part of the Baltic proper, and at the same time the fishery with the otter seine was carried on more intensively. After the Swedish research vessel "Skagerak" had revealed in 1921 what great catches could be made around Bornholm, Swedish fishermen started an intensive plaice fishery in these waters. During the years immediately following, Danish fishermen also visited the waters around Bornholm in large numbers in order to fish for plaice. The quality of the latter had now improved to such a degree that marketing them presented no difficulties. The Danish fishing villages on the Baltic, where previously fishing for plaice had only been carried on to a comparatively slight extent, became gradually the headquarters for a number of vessels which were employed chiefly or exclusively in fishing for plaice. The development of this fishery can be traced from the table of statistics given below which has been taken from the annual Fiskeri-Beretninger, issued by the Fishery Director F. V. Mortensen (4).

Whilst the number of smaller vessels under 5 Tons has not changed much during these years, a considerable increase has taken place in the number of larger motor vessels, especially of the size 5—15 Tons which is the type most frequently used when fishing

Table 2. Number of fishing implements for the capture of plaice and number of motor vessels in the Baltic proper during the years 1919—26.

	Plaice nets	Danish seine	Otter seine	Motor vessels 50—15 Tons	15—5 Tons	Under 5 Tons
1919	1141	2	94	2	59	341
1920	1121	4	89	5	63	347
1921	1246	10	98	3	78	325
1922	1258	24	103	5	85	323
1923	1369	96	169	12	90	332
1924	1229	112	422	14	109	325
1925	1389	110	558	18	126	339
1926	1484	104	604	12	143	325

for plaice. At the same time the number of fishing implements for plaice has greatly increased, chiefly in respect to the Danish seine and the otter seine. Particularly on Bornholm a great development has taken place as regards the procuring of vessels and implements for the capture of plaice.

Fishermen from other parts of Denmark have also during these years turned their attention to the Baltic to an ever increasing degree in order to take part in the plaice fishery there. From the harbours of the Kattegat, Limfjord, and the North Sea, fishermen have come in large numbers, so that often hundreds of boats for catching plaice lay in the Bornholm harbours.

An immense increase in the intensity of fishing has thus taken place during the years subsequent to 1919. It is especially noteworthy that the number of otter seines more than doubled from 1923 to 1924. In the course of the last two years 1926 and 1927, the number of Danish fishermen has, however, declined to some extent as a consequence of the fall in the yield per boat which has taken place in recent years. This will be discussed more closely in the following chapter.

c. Decrease in the catch per fishing unit in the course of years.

On the cruises carried out for the Biological Station in the Baltic proper during the years 1925—27 information concerning the yield of the fishery has always been obtained from both fishermen and the local fishery officials. The Danish fishery with the Danish seine commenced in the western part of the Baltic proper in the year 1919, and in 1920 fishermen using the Danish seine arrived in great numbers from other localities, but the position of the fishery then shifted, as it gradually became less profitable in the western part of the waters, more and more eastwards towards the waters round Bornholm. A selection of the data collected is given below.

1920: Sept. 11th. Fishermen in Klintholm harbour (Møen). The plaice here have become larger and better in recent years. Fishermen from the Sound now fish with the Danish seine S. and S.E. of Møen; they have never done this previously. The yield is 750—1000 kg. per boat per day. Also many German fishermen fish between Møen and Rügen. Many fishes below the size limit in the catches.

1921: April 14th. Fishermen in Klintholm. About 30 vessels fish for plaice S.S.E. of Klintholm with otter seine and Danish seine. They capture between 40 and 100 score of plaice above the minimum (weight, 4—5 kg. the score) per boat per day, but at least double as many below the minimum.

August 20th. Fishermen in Klintholm. Fishing takes place mainly between Møen and Rügen and on the edge of the Kadetrende. About ten score plaice can be caught per haul with the Danish seine (1200 m. lines), or up to 100 score per day, but the average is 5—6 score per haul; the weight is 6—6$^1/_2$ kg. the score.

1923: August 8th. Fishermen in Stubbekøbing. There is now very little fishing for plaice off Møen and Gedser, but it is carried on in some localities off the German coasts and Bornholm.

August 11th. A fisherman from Gilleleje who has fished for four years in the Baltic declares that to the north of Bornholm it is common to hear of catches of 100 score plaice in one haul with the Danish seine. Fishing is now best on the Adler Ground and around Bornholm. In the western part of the Baltic proper the quantity of fish has decreased considerably. In the first year the boats could be filled with 3—4 hauls with the Danish seine, but now it takes 3—4 days.

August 15th. A fisherman from Hundested who was one of the first to begin fishing in the Baltic in the summer of 1920 states that the quantity of plaice in the waters between Møen and Rügen has decreased considerably since then, but the quality has improved. The average catch is now about 25 kg. per haul (= 4—5 score plaice). Many fish under the size limit are caught inshore, but where the depth exceeds 25 m. the fish are large almost without exception.

1924: June 26th. Danish seine fishermen from Rødvig. Plaice are not so abundant here as they were 3—4 years ago. Fishermen often catch only about 50 kg. per day.

August 1st. A net fisherman in Køge Bay. The plaice here have improved in quality during recent years but have decreased in number. 20 score plaice are often caught in 20 gill nets, weight 5 kg. the score, but good fish and full of vitality.

August 2nd. Otter seine fisherman from Rødvig. Three score plaice are caught per haul, many of them being below the size limit.

August 16th. Fishermen from Svaneke (Bornholm). Plaice are not so plentiful off Bornholm as formerly. The quality is quite good, but they are not so full of vitality, since they are caught in deep water.

1925: April 17th. Otter seine fishermen from Kerteminde, in Rønne harbour (Bornholm). 30—50 score plaice are on an average caught per day, weight 5 kg. the score. The quantity has, however, decreased. Last year 170—200 score were often caught per day.

April 23rd. Fishermen in Rønne harbour. The plaice off Bornholm have improved during the last 3—4 years, but the quantity has decreased.

July 23rd. Otter seine fisherman from Kerteminde, fishing to the west of Rønne. About 4 score plaice are caught per haul (of 2 hours each). Weight 7$^1/_2$ kg. the score. The density has decreased since last year, but the quality has improved. 200—250 kg. per day are caught at the outside. There has been, however, one case of a vessel catching

700 kg. in two days on the Oder Bank. Two other otter seine fishermen in the vicinity caught only 2 and 3 score plaice respectively per haul (2 hours).

July 28th. Fishery official, Rønne. The yield is smaller than last year. Many of the cutters from other parts of Denmark and from abroad return home since fishing is unprofitable. The price is too low and the fish are lacking in vitality.

July 30th. Two otter seines from Tejn (Bornholm) caught 20 and 30 score plaice respectively per day, weight 6 kg. the score.

August 2nd. Otter seine fisherman from Middelfart, fishing to the west of Rønne. 2—4 score plaice per haul ($1^1/_2$ hours). Average daily yield 100—200 kg. = 15—25 score, weight 7 kg. the score.

1926: June 8th. Kriegers Flak. Otter seine fisherman from Sejerø. Bad fishing throughout the whole area. A week ago up to 100 kg. per day could be caught here.

June 8th. North of Darss. Danish seine fisherman from Samsø. Up to 66 kg. per day.

August 6th. Fishery official at Rønne. Density steadily on the decline. One vessel took, however, recently 700 kg. in two days, but prices are low.

August 12th. Otter seine fisherman from Kerteminde fishing to the west of Rønne. 4—5 score plaice caught per haul ($2—2^1/_2$ hours). Scarcely any fish below the minimum.

1927: August 28th. Fishery official at Rønne. Density of plaice stock still less than last year. Fishermen seldom catch more than 100 kg. per day.

Various data can also be obtained from the official monthly reports on fishing from the Fishery Superintendent for the Islands regarding the yield of the catches for the years 1922—27; unfortunately no information is available as regards the daily yield of the cutters for the years 1920 and 1921. In the table below are collected reports on the yield per boat per day in addition to other facts of interest when such are entered in the report, e. g. the number of the boats engaged in the fishery etc. When no special facts are given, the data refer to the average yield of Danish vessels.

Table 3. Selection from the monthly reports from the Fishery Superintendent for the Danish Islands.

A. Off the coasts of Sealand-Møen-Falster.

Year	Catch per boat per day	Vessels engaged etc.
1922.	Summer months: 200—500 kg.	
1923.	April: Up to 250 kg.	May: Fishing is carried on by many vessels right down to the German coast.
	May: 125—150 kg.	
	June: Up to 500 kg. (a score = 6—7 kg.)	June: Fishermen from all parts of Denmark, e. g. Frederikshavn, Grenaa, etc., are engaged in fishing at Kadetrenden and S. and E. of Møen.
	Oct.: Up to 200 kg.	Oct.: All the vessels from Isefjord now fish in the Baltic.
1924.	April: Up to 150 kg. (a score = 4 kg.)	
	Sept.: Up to 700—800 kg.	
	Nov.: Up to 300 kg.	

Year	Catch per boat per day	Vessels engaged etc.
1925.	June: Up to 200 kg.	June: Better quality than formerly.
	Nov.: About 100 kg.	
1926.	Oct.: 120—150 kg.	
1927.	Febr.: 12—20 score.	
	March: 100—125 kg.	
	June: 50—75 kg.	

B. Waters around Bornholm.

Year	Catch per boat per day	Vessels engaged etc.
1922.	Aug.: Swedish fishermen up to 100—200 score.	Sept.: Danish fishermen have also now begun fishing for plaice N. of Bornholm.
	Nov.: 50 score. Swedish fisherman: 266 kg.	
1923.	Jan.: 72 score.	March: On Bornholm and at Christiansø there are now 14 vessels altogether, which are used for the plaice fishery. Of these 8 are new, 6 are welled smacks which have been equipped for the Danish seine fishery.
	Febr.: 30—70 score.	
	March: Up to 100 score (about 600 kg.)	
	April: 75 score.	
	May: Up to 60 score.	
	July: Up to more than 1000 kg. (100 score per haul with the Danish seine.)	
	Oct.: Up to more than 1000 kg. (75 score per haul.)	
	Dec.: 20—30 score.	
1924.	Jan.: Tejn: 60—150 score.	May: Vessels from Nyborg, Kerteminde, and Gilleleje engaged in fishing.
	May: 40—120 score.	June: Quality better than last year.
	June: 300—500 kg.	July: About 40 home vessels, Danish cutters apart from those from Bornholm are engaged in fishing.
	Oct.: 30—70 score.	Nov.: About 30 cutters from Esbjerg, Frederikshavn, Grenaa, Hundested, and Gilleleje in addition to 2 vessels from Warnemünde engaged in fishing.
		Dec.: 95 cutters are engaged in fishing, of which 75 are from Bornholm.
1925.	Febr.: 10—40 score.	Jan.: Only 2 vessels from other parts remain. Fishery worse.
	March: 4—100 score.	March: 100 Bornholm cutters and 10 Danish cutters from others parts engaged in fishing.
	June: 150—300 kg.	April: 35 vessels from other parts of Denmark are fishing off Bornholm.
	Aug.: 200—600 kg.	May: Fishery far worse than in May of last year.
	Nov.: 100—450 kg.	June: 30 cutters from other parts of Denmark. Quality fairly good.
		July: Fish lack vitality.
		Aug.: Fairly good quality.
		Sept.: Only 10 vessels from other parts of Denmark remain.

Year	Catch per boat per day	Vessels engaged etc.
1926.	Jan.: 100—200 kg.	
	July: 50—350 kg.	
	Nov.: About 100 kg.	
	Dec.: 100—200 kg.	
		Sept.: Plaice are scarce. Fishermen cannot cover expenses.
1927.	Jan.: About 150 kg.	
		Jan.: 40—50 vessels, amongst which many are German.
	July: 1st half: 100—150 kg. 2nd half: on the wane.	
		April: Only a few Bornholm vessels engaged in fishing but about 20 German cutters.
	Aug.: Rarely 100 kg., generally considerably less.	
	Sept.: 50—100 kg.	
		Sept.: Most of the vessels from other parts have left. No German vessels.
	Nov.: 1st half: Poor yield. 2nd half: 100—150 kg.	
		Oct.: Catches are seldom more than enough to cover expenses.

In Figs. 1 and 2 the data given above relating to the daily yield per boat are presented graphically; where the yield is given in scores it is in every case as far as possible converted into kilograms.

Both the information furnished by the fishermen and the official reports show that the yield of the plaice fishery per unit of fishing in the Baltic proper has decreased in the course of the years 1920—27, gradually but to an extent that has been very much felt. Both off Bornholm and in the waters between Møen and Rügen, the daily catch per boat has decreased in the course of these seven years to about one tenth, namely from about 750—1000 kg. to about 75—100 kg. per day per vessel.

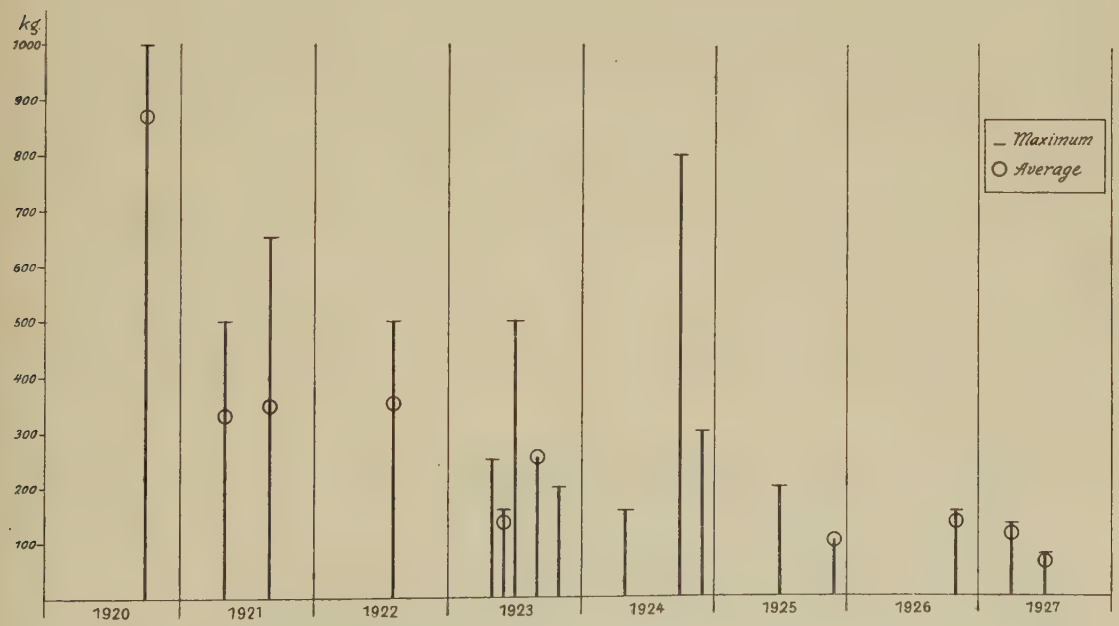

Fig. 1. Catch per boat per day in the years 1920—27. Off the coasts of Sealand-Møen-Falster.

That the density of the plaice was on the decline was also proved by the fishing experiments carried out by the Danish Biological Station in the Baltic during the years 1925—27, in which the "Eel-tog" was employed, a fine-meshed implement which is admirably adapted to quantitative fishing. In Table 4 below is given the average number of plaice caught per 15 minutes' haul with "Eel-tog". The figures in brackets give the respective numbers of the stations.

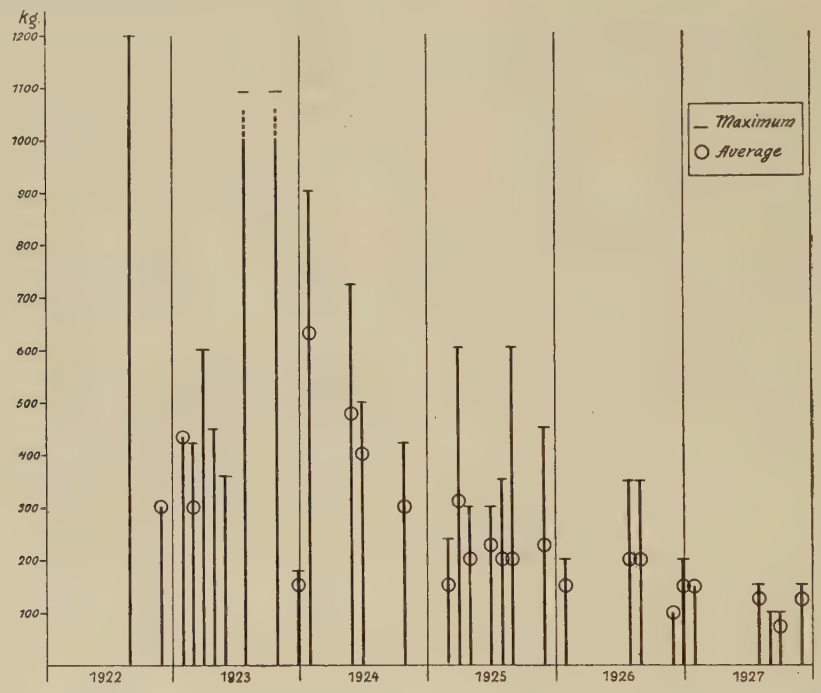

Fig. 2. Catch per boat per day in the years 1922—27. Waters around Bornholm.

Table 4.

	Coasts of Sealand-Møen-Falster	Arcona Basin	Rønne Bank	E. and N. of Bornholm
1925	9.0 (29)	2.2 (7)	17.8 (7)	7.6 (6)
1926	2.7 (11)	3.5 (3)	11.4 (2)	9.2 (5)
1927	1.2 (25)	2.0 (16)	2.9 (7)	0.2 (9)

It will be seen that the catches in 1927 are everywhere considerably less than in 1925 and 1926.

d. Changes in the rate of growth of the plaice and in the age composition of the stock. Improvement of quality contemporaneously with decrease of quantity.

C. G. Joh. Petersen (14) by comparing his own material from 1920 with that of Professor Reibisch from 1909 proved that both in the western Baltic (S. of Langeland) and in the Baltic proper (S. of Møen) the plaice stock in 1920 grew more rapidly

and was composed of comparatively younger year classes than the stock in 1909. The same writer compared in 1922 (15) the average lengths of the age groups taken separately for the years 1908—09 (Reibisch) with the corresponding lengths for 1920—21 (the material having been partly brought from fishermen and partly furnished by the Danish Biological Station's own fishing experiments) and found that the average lengths in 1920—21 exceed the average lengths in 1909 by about 10 cm. in the western Baltic S. of Langeland, and by about 2—4 cm. in the Baltic proper between Møen and Rügen. The writer moreover emphasizes that the density of the plaice stock has decreased very considerably and that the fishermen's catches in 1920—21 consisted of much younger fish than was the case in 1908—09; in the Baltic proper the bulk of the plaice captured in 1908—09 consisted of fish over 7 years old, in 1920—21 most of them were 5—7 years old. By marking experiments with plaice which were carried out to the south of Møen in the summer of 1923, A. C. Johansen showed that the growth of plaice was far more rapid then than in 1907 when corresponding experiments were carried out. Similarly the percentage of captured plaice indicated that the intensity with which fishing was carried on had greatly increased. Whilst at the marking experiments to the south of Møen in 1907 only about 10 per cent. of the marked fish were recaptured in the course of the first year after liberation, the corresponding percentage at the experiments in 1923 had risen to 35.8 (A. C. Johansen (6), C. F. Drechsel (3)).

Finally C. G. Joh. Petersen (16) by comparing the catches for the years 1921—24 at a certain place to the south of Møen came to the conclusion that the growth of the plaice had become more rapid during this period and their quality had improved, but that the density of the stock had at the same time considerably decreased. He pointed out moreover that the 1919 year class far exceeded in numbers the other year classes in all the samples taken.

Swedish investigators have also studied the plaice stock in the Baltic proper, especially during the years 1921—25, and the material collected has been worked up by A. R. Molander (9) and (10). Also this writer comes to the result that the plaice stock in the Baltic proper has decreased considerably in numbers, but that the rate of growth has increased. Molander proves as regards the Baltic proper, in agreement with the conclusions of Strodtmann and Langhammer (18) as regards the western Baltic, that the years 1914 and 1916 were unusually abundant years for plaice fry, the plaice from these two year classes being predominant in number for several years. Finally the present writer (1) has called attention to the fact that the renewal of the plaice stock in the Baltic proper can in certain years (as for instance 1924) be an almost complete failure. Thus 1922 and 1924 were bad years for plaice whereas 1921, 1923, and 1925 were good.

All writers thus agree that in recent years a very great change has taken place in the plaice stock in the Baltic proper. The stock has been thinned to a great extent but an improvement in quality has taken place at the same time, the plaice being now on an average far younger and growing more rapidly than formerly. The present writer and Dr. Molander agree that this change is due to the great increase in the intensity of fishing which has taken place in the Baltic during recent years. All writers

moreover agree that energetic measures should be adopted as soon as possible in order to protect the stock, which is threatened with becoming so depleted that fishing will no longer be profitable.

In order to investigate whether the change in the stock described above has possibly made further strides in recent years, material has been constantly collected by the Danish Biological Station, partly by means of fishing experiments carried out from the Station's steamer "Japetus Steenstrup", partly by purchasing samples of fishermen's catches. In the following I shall give the main results obtained.

1. Rate of growth.

Waters off the coasts of Sealand-Møen-Falster. For comparison with A. C. Johansen's (5) and Strodtmann and Langhammer's (18) age determinations of plaice from the Møen area in 1907 and 1922 respectively, I have in the table below given the average length of the plaice from the same area, caught with the Eel-tog in August 1921 and August 1924.

Table 5.

	III-gr.		IV-gr.		V-gr. and older	
	♂	♀	♂	♀	♂	♀
1907 (A. C. J.).....	14.6 cm.	15.5 cm.	16.1 cm.	18.4 cm.	20.2 cm.	24.0 cm.
1921 (H. B.)	17.4 -	18.2 -	19.7 -	21.2 -	21.0 -	24.0 -
1922 (S. & L.).....	20.8 -	20.7 -	21.4 -	22.1 -	23.2 -	26.7 -
1924 (H. B.)	23.2 -	24.6 -	24.8 -	25.9 -	26.6 -	26.9 -

It will be seen that the increase in rate of growth in the course of 13 years, from 1907 to 1921, is not nearly as great as the increase which has taken place in the three years, 1921 to 1924, where it asserts itself literally from one year to the next. Both Dr. Johansen's and my figures represent biological catches, whereas Strodtmann's represent German fishermen's catches; since, however, plaice under the size limit are included the figures are no doubt representative. It is possible, however, that Johansen's and Strodtmann's figures should be increased a little in order to be comparable with mine, because the fish investigated by them were caught in March and May-June respectively, whereas mine were caught in August. The great increase of the rate of growth during recent years will thereby become still more striking.

If we compare the average lengths of the same year classes in the fishermens' catches (in which plaice under 25 cm. in length are eliminated by sorting) in the same area for the years 1924—1927 we obtain the following figures.

Table 6.

	III-gr.		IV-gr.		V-gr.	
	♂	♀	♂	♀	♂	♀
July 23rd, 1924....	..	..	26.5 (11)	26.6 (9)	27.1 (20)	28.6 (19)
Aug. 1st-16th, 1924..	..	..	26.5 (23)	26.9 (31)	27.1 (20)	27.9 (20)
June 4th-9th, 1926..	25.5 (8)	27.2 (9)	27.0 (1)	29.4 (5)	27.4 (5)	31.0 (2)
Nov. 1st, 1927	27.0 (3)	29.0 (5)	28.8 (41)	31.4 (43)	30.0 (3)	32.0 (12)

The figures in brackets give the number of specimens investigated.

Also these figures thus show a distinctly increased average length of each age group. A further testimony to the same effect is the fact that whereas fishermen in 1924 caught no plaice at all of the II-group because they were all under the minimum and only few of the III-group because the average length of this group was less than 25 cm. (see Table 5), in 1926 the III-group was the most abundant age group in the fishermen's catches and in 1927 even the II-group fairly well represented, as it constituted no less than 19 per cent. of the fishermen's catches in a large sample from Møen on Nov. 1st 1927. This has, so far as I know, never been observed previously in the Baltic.

Waters around Bornholm. From the waters around Bornholm material for comparison is available from biological catches on Rønne Bank (S. of Bornholm) made in 1925 and 1927; the average lengths of the II- and IV-groups, which in each of these two years were the most abundant of the groups, are given below.

Table 7.

	II-gr.		IV-gr.	
	♂	♀	♂	♀
August, 1925	12.4 (39)	13.6 (16)	22.9 (61)	26.0 (11)
August, 1927	13.3 (6)	..	23.5 (15)	27.4 (9)

As before, the figures in brackets give the numbers of the specimens investigated.

Also in this case the growth rate has thus increased considerably in the course of only two years. In the fishermen's catches, both from the Arcona Basin and to the south and east of Bornholm, between 2 and 8 per cent. were found in 1927 to belong to the II-group; a considerable number of fish of this group have thus now reached at the age of $2^1/_2$ years a length of over 25 cm., which has hitherto been unheard of in the waters around Bornholm.

2. Age composition of the stock.

I have collected in the table below the results of the age determinations made from the entire material collected by the Biological Station during the last four years of plaice from the Baltic proper. This material has been furnished by many different stations in nearly all the areas in these waters. It is arranged according to year classes, and the biological catches which have been carried out by means of the Eel-tog, a kind of trawl with such fine meshes that plaice down to 4 cm. in length are retained, are entered separately from the catches purchased from the fishermen, where the plaice under 25 cm. in length have for the most part been rejected. All the figures representing percentages are taken to the nearest whole numbers; the abundant year classes are indicated by underlining.

An examination of the biological catches in Table 8 shows that the year classes 1921, 1923, and 1925 have been very abundant for a number of years; also the year classes 1919 and 1920 were still in 1924 particularly plentiful. The year classes 1922,

Table 8. Distribution of year classes. Plaice from the Baltic proper 1924—1927.

Year class	1927	26	25	24	23	22	21	20	19	18	17	16	15	14	13...	Nos. of spec. invest.
1924 Biological catches (%)	..	..	..	1	**22**	4	**17**	**30**	**18**	3	1	1	1	1	2	410
1924 Age groups..	..	..	..	0	I	II	III	IV	V	VI	VII	VIII	IX	X	X+	
1924 Fishermen's catches (%)	..	..	..	..	..	..	**15**	**25**	**48**	6	3	1	..	..	3	81
1925 Biological catches (%)	..	..	**25**	1	**19**	10	**26**	7	2	2	3	1	2	..	..	1344
1925 Age groups..	..	..	0	I	II	III	IV	V	VI	VII	VIII	IX	X	..	..	
1925 Fishermen's catches (%)	..	..	..	..	..	10	**29**	5	6	11	15	8	7	..	..	84
1926 Biological catches (%)	..	1	**14**	1	**28**	11	**24**	4	2	4	6	2	..	..	..	191
1926 Age groups..	..	0	I	II	III	IV	V	VI	VII	VIII	IX	X	..	..	..	
1926 Fishermen's catches (%)	..	..	..	..	**28**	26	**31**	7	3	3	2	..	..	..	..	61
1927 Biological catches (%)	1	..	**15**	4	**53**	9	6	3	1	1	1	6			..	135
1927 Age groups..	0	I	II	III	IV	V	VI	VII	VIII	IX	X	X+				
1927 Fishermen's catches (%)	..	..	6	10	**62**	9	6	1	1	1	1	2			..	888

1924, and 1926 were on the other hand less abundant throughout all the years in which the investigations took place. This can be explained, as I have previously established (2, pp. 31, 32), as an expression of the fact that the same amount of fry has not developed each year, but "good" fry years have alternated with "bad" years (2, p. 30). According to Dr. A. C. JOHANSEN's (6) and my own (2) investigations, the year classes 1923 and 1925 were abundant also in the Belt Sea and the southern Kattegat, whereas the year classes 1922, 1924, and 1926 were comparatively poor. It may be added that also the 1927 year class which according to the coastal investigations as mentioned above (p. 31) was abundant in the Baltic, was also abundant in the Belt Sea and the southern Kattegat. The fact therefore that the year classes 1923, 1925, and 1927 were abundant, whilst on the other hand the year classes 1922, 1924, and 1926 were less abundant, thus holds good for the entire Baltic race of plaice.

When considering the fishermen's catches, it must always be borne in mind that the smaller fish have not been retained. This may cause a poor year class to be more numerously represented in the catch than a following rich year class, since the more numerous but younger and consequently smaller plaice hatched in the latter year for the most part escape through the meshes of the fishing nets. We see from Table 8 that the fishery is based mainly on the IV- and V-groups, with the exception of those years in which these age groups represent a bad fry year. We can also see how rapidly

the abundant year classes are depleted by fishing. Thus in 1924 the two year classes 1919 and 1920 were very plentifully represented, but already in the following year 1925 they constituted only a comparatively small proportion of the catch. Both in 1925 and 1926 the 1921 year class was the most abundant; the abundant 1923 year class could not yet make itself felt because so many fish escaped through the meshes. Not until 1927 did this year class predominate over all the others, constituting no less than 62 per cent. of the fishermen's catches. The 1921 year class has now for the most part been captured, and of the new abundant 1925 year class (II-group) a large proportion still escapes through the meshes of the nets; I have mentioned above that this is the first time I have ever found plaice of the II-group in the catches of Danish fishermen in the Baltic proper; off Møen where plaice grow rather more rapidly than off Bornholm, the II-group was three times as numerous as the III-group in the fishermen's catches.

In consequence of the above we can conclude with some degree of certainty that round about 1920 we had a sequence of comparatively good fry years in the Baltic proper, viz., 1919, 1920, and 1921. We may presume that this circumstance was one of the reasons that the yield of the Danish and Swedish plaice fishery in 1924 was so unusually great (see below). Since that date good and less good fry years have alternated regularly, and 1924 is thus the only one of the years under discussion in which three consecutive year classes have been abundantly represented.

3. Improvement in quality.

It has been mentioned above that an increase in the growth rate has taken place simultaneously with a decline in the quantity, but at the same time an improvement has occurred in the quality or state of nutrition of the Baltic plaice. This is confirmed by both the fishermen themselves and the consumers. Whereas previously it was scarcely possible to market Baltic plaice in Copenhagen, there is now a great demand for them there. The quality of the plaice from the Bornholm Deep during the spawning period and the following months still leaves something to be desired, and as the supply in the last few years has exceeded the demand, the prices of Bornholm plaice have been on the decline f om 1923—26, but seem, however, now (1927) to show signs of rising. For the plaice from the Arcona Basin and the eastern shores of Sealand-Møen-Falster the average price per kilogram was as follows:—

In 1923	68	Danish	Øre.
- 1924	79	—	—
- 1925.....	83	—	—

The advance in price during these three years was thus fairly appreciable. It can scarcely be doubted that the reason for this improvement in quality is to be found in the easier access to plentiful food which has been a consequence of the great thinning of the stock brought about by fishing (C. G. Joh. Petersen (14), p. 5). This has resulted in a more rapid growth and a better state of nutrition than formerly. The following facts bear witness to the correctness of this explanation:—

1) The improvement in quality has advanced in the same proportion as the density of the stock has declined. It first became apparent therefore in the western part of the Baltic proper, then in the Arcona Basin, and finally in the waters around Bornholm.

2) Analogous cases are found in the Kattegat, Belt Sea, and the western Baltic. What has happened in the last 7—8 years in the Baltic proper is only a repetition of what happened previously in these waters in the above mentioned sequence. As an "accumulated" stock of old, badly nourished fish was gradually depleted by fishing, it was in every case replaced by a less numerous, but on the other hand far more rapidly growing and better nourished stock of comparatively young plaice.

e. Total yield of the plaice fishery in the Baltic proper.

It is obvious that in itself it is advantageous to have a stock of old, slowly growing, and lean plaice replaced by a young, rapidly growing stock, even if the latter is somewhat less dense than the original one. The question is only, to what degree can it be profitable to reduce the density, for the growth rate can of course only be increased up to a certain limit. The greatest yield is obtained from an area when it is fished in such a way that the least possible work gives the greatest possible number of kilograms which will command the highest possible price. But there must not be taken more each year than the stock is able to produce. If more is taken than the stock can produce by reproduction, the fishing is too intense. If then the intensity of fishing remains constant (or increases) the result will be that the total yield in kilograms per year will decrease.

In the table below is given the yield of the Danish plaice fishery in the Baltic proper according to the annual Fishery Reports (Fiskeri-Beretninger, 4). The entries of the plaice catches landed in Copenhagen are derived from the same source, whilst the entries from Bornholm are based on special data furnished by the Fishery Director F. V. Mortensen. The yield is in every case given in metric tons.

Table 9. Yield in metric tons of the Danish plaice fishery in the Baltic proper.

Year	Total yield	Landed in Copenhagen, caught in the Arcona Basin and off the coasts of Sealand-Møen-Falster	Landed in Bornholm harbours, caught in the waters around Bornholm
1913	28	..	..
1914	28	..	..
1915	32	..	..
1916	42	..	..
1917	31	..	..
1918	33	..	..
1919	139	..	..
1920	179	106	..
1921	278	211	..
1922	322	243	2
1923	1006	456	378
1924	2009	466	994
1925	1639	234	1116
1926	1293	210	832

It will be seen from Table 9 that whereas the plaice fishery in the Baltic proper was practically devoid of all importance in the years previous to 1919, the fishery began in that year to assume larger dimensions. For the first years after this, Danish fishermen only fished the western part of these waters, and the yield increased steadily as more

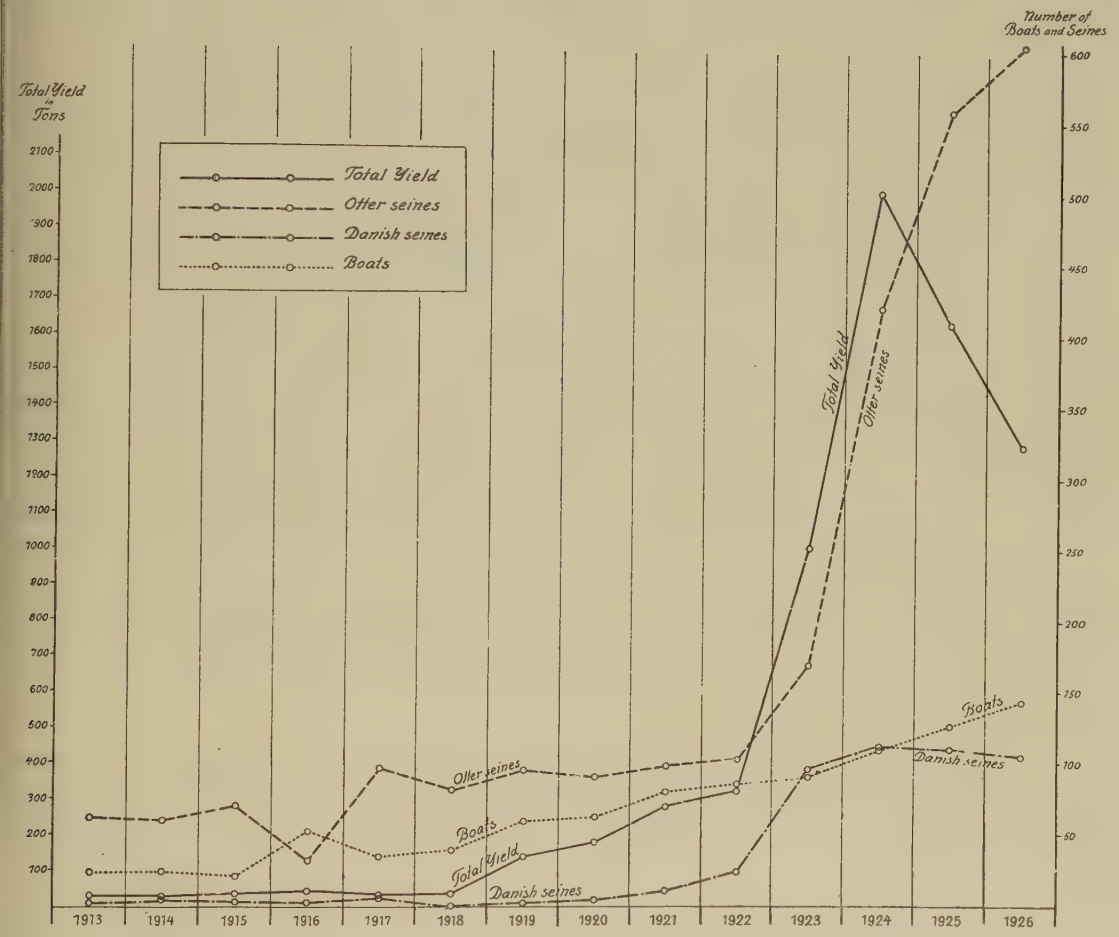

Fig. 3. Yield of the Danish plaice fishery, number of otter seines, Danish seines and motor boats 5—15 tons, in the Baltic proper 1913—26.

cutters gradually came to take part in the fishery. In 1923 the fishery around Bornholm commenced and greatly swelled the yield, but already in 1924 the total yield culminated and declined in the two following years[1]). The landings in Copenhagen of fish from the western part of the waters culminated already in 1923—24, from Bornholm on the other hand not until 1925.

In Fig. 3 the fluctuations in the total yield are presented graphically, together

[1]) It may be added that we can expect the yield for 1927, when the catch per vessel per day was, as mentioned above, still less than in 1926, to prove still worse than the yield for 1926.

with the curve for the number of motor fishing boats, stationed on the Danish shores of the Baltic proper, of between 5 and 15 tons which as mentioned above is the type most frequently used for the plaice fishery. The curves for the numbers of otter seines and Danish seines on the coasts are also plotted; all the entries relating to vessels and gear are taken from the Fiskeri-Beretning (4). The figures for 1919—26 are given in Table 2.

Since the numbers of motor vessels and seines give a fairly reliable picture of the intensity with which fishing for plaice is carried on from the fishing villages in question, we can see that it has been steadily on the increase, even after the total yield began to decline. As mentioned above, an increasing number of Danish vessels from other fishing villages took part in the fishery from the year 1919 onwards; they came again year after year as long as fishing was at all remunerative. It has also been mentioned above (see Figs. 1 and 2) that the yield per unit of fishing has been rapidly declining since the intensive fishing commenced.

All these circumstances point towards the increasing total yield of the plaice fishery from 1919 to 1924 being due to a still more rapid increase in the intensity of fishing; that the yield then declined in 1925 and 1926 can only have been due to depletion. This has evidently taken place, as the figures in Table 9 indicate, earlier in the western coastal area than in the waters around Bornholm.

Also the yield in kilograms of the Swedish plaice fishery in the Baltic show a steeply rising curve which culminated in 1924, and then a fall in the two following years, i. e. in complete accord with the yield of the Danish fishery. It is therefore perfectly justifiable to say that in the areas of the Baltic proper where the Danish and the Swedish fisheries are mainly carried on, namely, on the western shores, in the Arcona Basin and the Bornholm Deep, fishing has been carried on too intensively since 1924.

The stock is now accordingly thinned to a much too great extent. It is therefore necessary to find means to remedy this state of affairs. In the following chapter we shall consider more closely the measures which may be presumed to be the most suitable.

f. Measures of protection.

In order to estimate the stock of fish in any given waters, two factors are particularly important, namely the rate of growth and the density of the stock. According to experience gained in other Danish waters, and taking into consideration the quantity of plaice food which is present in the Baltic proper, we may assume that the growth rate of plaice in these waters has now about reached its maximum. The density on the other hand, after the excessive fishing of the last few years leaves much to be desired. To judge from the fall in the yield per vessel per day, the density should now be only about one tenth of that which prevailed when the intensive fishing commenced. For the time being, therefore, it is only a question of increasing the density. The most effective way to achieve this is undoubtedly the introduction of a suitable protection for plaice, and here we can proceed in two ways as we can protect either the young or the adult fish.

1. Measures of protection for young fish.

As the older plaice are gradually captured, the future of the fishery becomes in an ever increasing degree dependent on the yearly upgrowth of the fry along the coasts. In the Baltic proper, where as mentioned above the renewal of the stock can in certain years be an almost complete failure, protection of the young fish which grow up along the coasts is therefore a very important matter. It appears namely (see (1) p. 35), that in the Baltic proper, where hydrographical conditions are often particularly unfavourable to the development of the eggs and fry of plaice, a relatively far lower number of fry grow up in the "bad" plaice years along its shores than in the neighbouring waters, i.e. the Belt Sea and the western Baltic.

The fishing implements which are especially injurious to the young plaice (0-, I-, and II-groups) in the localities they frequent along the coasts, are the otter seine and the Danish seine; although most of the fry of these groups either pass through the meshes of the nets or are under the minimum imposed by law, it is, however, unavoidable that a number of them are destroyed, particularly in the warm season, by the seine fishery. Since in addition the older and more valuable plaice only seldom come inshore, there is good reason to prohibit all fishing with otter seine and Danish seine in territorial waters along the Danish shores of the Baltic proper. A similar closure of the most important nursery grounds was introduced long ago along the east coast of Jutland, and also imposed by by-laws in many of Denmark's fjords and in the bays on the islands.

Such a closure involves only one danger, that the density in the protected areas may again become so great that the growth rate of the young plaice is lessened. As regards the Baltic proper, however, there is not much likelihood of this taking place.

2. Measures of protection for the adult fish.

The adult fish also need measures of protection, first and foremost because it is unremunerative to fish for plaice, before they have reached a profitable size and value. Considering the enormous increase in the growth rate which has occurred in recent years, the Danish size limit now in force for sale on the open shores of the Baltic (21 cm. total length) is absurdly small. Such a low size limit was justified in the case of the original stock of old, slowly growing fish, because many of the plaice, especially the males, took 8—10 years to attain such a size (Reibisch (14)); Table 5 in this paper shows that in A. C. Johansen's material from Møen the average length of all males over 5 years of age in 1907 was only 20.2 cm., but that the average length of the III-group was already in 1924 far above 21 cm. A size limit of 21 cm. therefore at the present time protects for the most part only the plaice of the two youngest year classes; no closer explanation is necessary to show that such a size limit is too low. It must, however, be mentioned that since most of the plaice which are captured in the Baltic are not landed and sold on the open shores, the size limit for the greatest part of that portion of the catch which is sold in Denmark is 25.7 cm. In waters such as the Baltic proper where different nations carry on an intensive plaice fishery side by side, the size limit ought, however, to be

international; that the Danes protect all plaice under 25.7 cm. is not of much avail when the Germans capture them right down to 18 cm. It would therefore be of the greatest importance both for the Danish fishery and for the plaice stock altogether if an agreement could be reached between the countries interested as to a common minimum for plaice in the Baltic proper.

An international size limit, as high as possible ought therefore to be instituted immediately. It is obvious that the effects of the measures adopted should in future be closely followed up by regular scientific investigations.

We may hope that by means of such measures as these two, a closure of the coastal tracts and an increased size limit, the fall in the yield of the plaice fishery in the Baltic proper may be checked. If on the other hand nothing is done to protect the thinned stock of plaice in the Baltic, the consequences will infallibly manifest themselves. In such a case the yield will in all probability steadily fall until it actually becomes unprofitable to carry on the plaice fishery. For the fishermen round the shores of the Baltic and especially for those on Bornholm, who have acquired vessels and gear in large numbers which are suitable only for the plaice fishery, this would mean a catastrophe. It must therefore be hoped that the measures of protection, such as those mentioned above, may be adopted as soon as possible by means of an agreement between the countries interested.

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3. On a proposed close Season for the Plaice Fishery in the Belt Sea and the Baltic

by

A. C. Johansen.

a. Introduction.

At the meeting in Copenhagen in November 1927 of the Transition Area and Baltic Area Committees, it was agreed to propose a close season for plaice in the Belt Sea and the Baltic during the period from January 15th to April 15th.

According to this proposal it should be forbidden to land plaice during this period in the harbours or on the coasts bordering on the areas of water in question.

The aim of the introduction of such a close season is partly the protection of the fish from capture during the most important part of their spawning period and partly their protection during a period of the year when their quality and commercial value are comparatively low.

The desire to protect the plaice during the most important part of their spawning period will be best understood if it is borne in mind that the quantity of the plaice fry in the bottom stage produced annually is feared to be on the decline, and that it is regarded as probable that under similar external conditions more fry will be produced if there is a large egg production in a given area than if there is only a small egg production. The fear of a decline in the quantity of fry is due chiefly to the fact that an unusually great decrease in the total yield has been observed, as also a great diminution in number of mature plaice in the southern Kattegat, Belt Sea and the western parts of the Baltic, where the plaice fishery is of particularly great importance.

The stock of plaice in different waters has reacted towards the fishery in a somewhat similar manner. In the first stage the yield of the fishery increases proportionate to the intensity of fishing. Then comes the second stage: the yield increases somewhat, but not in proportion to the increase in the intensity of fishing. Hereafter comes the third stage: the yield reaches a maximum, which can not be surpassed however much the intensity of fishing is increased. Now comes the fourth stage: the yield decreases, and when it has come down to a certain point, the intensity of fishing will also decrease, because the intense fishing will not pay now. Then comes the fifth stage: a balance where the yearly increase of the stock on account of the growth of the fish can make up for what is taken away by the fishery. The fluctuations in the yield are now mainly due to the effects of good and bad survival years for the young plaice.

In the course of the first three or four stages of this development there will come an improvement in the quality of the plaice. The old plaice, which are of a bad quality, will be captured, and young plaice of a better quality will replace them. In the later stages there is, however, a danger, that there will be a considerable decrease in the average size of the landed fish, so that a decrease in the quality will follow again. (Such a decrease has been observed in the Skagerak).

The statistics given below for the Kattegat, the Belt Sea, the Western Baltic, and the Baltic proper will indicate that the third stage of the fishery where the yield reaches a maximum, has been reached earlier in the Kattegat than in the Belt Sea, and earlier again in the Belt Sea than in the western Baltic. In the Baltic proper we are probably just in the period, when the yield is at its maximum, and a decrease is here soon to be expected.

It should be remembered that the conditions for the fishery were abnormal in the Kattegat, Belt Sea and Baltic in the period 1914—1919 on account of the Great

Table 1. Yield in Tons (1000 Kilogrammes) of the Plaice Fishery in the Kattegat in the years 1893—1926.

Year	Denmark[1])	Sweden[2])	Germany	Total
1893.....	3200	287	..	3487
1894.....	4000	277	..	4277
1895.....	3400	336	..	3736
1896.....	4200	433	..	4633
1897.....	3100	456	?	3556
1898.....	5100	476	?	**5576**
1899.....	4400	515	?	**4915**
1900..... ...	2900	519	?	3419
1901.....	3700	527	?	4227
1902.....	3900	639	?	4539
1903.....	3800	682	48	4530
1904.....	3300	719	94	4113
1905.....	2200	740	171	3111
1906.....	2300	696	183	3179
1907.....	3900	637	115	4652
1908.....	3300	658	162	4120
1909.....	3010	608	137	3755
1910.....	3168	607	177	3952
1911.....	3373	599	219	4191
1912.....	3203	407	145	3755
1913.....	3110	397	168	3675
1914.....	4186	601	109	4896
1915.....	3835	962	90	4887
1916.....	2404	365	66	2835
1917.....	2569	501	85	3155
1918.....	2295	463	29	2787
1919.....	3719	387	0	4106
1920.....	2324	300	52	2676
1921.....	1999	438	42	2479
1922.....	2014	429	71	2514
1923.....	2022	525	96	2643
1924.....	1858	586	94	2538
1925.....	2188	549	80	2817
1926.....	2243	..	..	..

[1]) The yield in the Skagerak from boats from Skagen included.

[2]) The yield comprises the catches in both the Kattegat and the Skagerak.

Table 2. Yield in Tons of the Danish Plaice Fishery in the Belt Sea in the years 1885—1926[1]). (The plaice fishery in the Belt Sea from other countries than Denmark is negligible.)

Year	Tons	Year	Tons
1885	433	1906	1163
1886	404	1907	801
1887	487	1908	1070
1888	622	1909	1044
1889	666	1910	1467
1890	708	1911	1777
1891	729	1912	**3352**
1892	617	1913	2681
1893	532	1914	1463
1894	546	1915	1011
1895	561	1916	906
1896	673	1917	1062
1897	494	1918	1089
1898	635	1919	2655
1899	645	1920	2056
1900	703	1921	1745
1901	1134	1922	1577
1902	787	1923	1363
1903	793	1924	1028
1904	1172	1925	1030
1905	1155	1926	854

Table 3. Yield in Tons of the Plaice Fishery in the Western Baltic in the years 1909—1926.

Year	Germany	Denmark	Total
1909	996	128	1124
1910	1160	72	1232
1911	1117	123	1240
1912	1229	142	1371
1913	1175	231	1406
1914	847	151	998
1915	579	110	689
1916	895	167	1062
1917	1244	140	1384
1918	1740	265	**2005**
1919	1657	342	1999
1920	1210	325	1535
1921	911	291	1202
1922	778	327	1105
1923	608	261	869
1924	392	267	659
1925	419	196	615
1926	382	230	612

[1]) The yield is taken from the Danish Fiskeri-Beretning. Until 1908 the Danish Plaice Fishery in the western Baltic and Baltic proper is included. The yield was in these waters in the period 1885—1899 less than 100 and in the period 1900—1908 less than 200 Tons per year.

War. In certain areas, as the Kattegat and Belt Sea, the fishing was hindered by mines etc., in other areas, as the Western Baltic, the intensity of fishing was in the period 1917—19 very great.

The great yield of the fishery in the Kattegat and Belt Sea in 1919 was probably due in the main to an accumulation of the stock of relatively old plaice during the years 1916—18 (in the Kattegat) or the years 1914—18 (in the Belt Sea).

Table 4. Yield in Tons of the Plaice Fishery in the Baltic proper in the years 1909—1926.

Year	Germany	Denmark	Sweden	Total
1909.....	4	59	14	77
1910.....	12	61	8	81
1911.....	57	58	5	120
1912.....	13	28	5	46
1913.....	32	28	2	62
1914.....	12	28	5	45
1915.....	51	32	4	87
1916.....	29	42	8	79
1917.....	71	31	11	113
1918.....	16	33	10	59
1919.....	57	139	9	205
1920.....	279	179	9	467
1921.....	335	278	15	628
1922.....	475	322	135	932
1923.....	1987	1006	419	3412
1924.....	1517	2009	648	4174
1925.....	2364	1639	432	4435
1926.....	2450	1293	400[1])	4143

b. The renewal of the stock of plaice in the Belt Sea and the Baltic.

The plaice which spawn in the southern Kattegat, Belt Sea including the Western Baltic, and Baltic proper (east of the line Gedser—Darsserort) are here referred to as the Baltic plaice. They have not a quite uniform racial stamp, but they all differ from the plaice which spawn in the North Sea and Skagerak by having a lower number of vertebrae and of dorsal and anal fin rays.[2])

Only comparatively few plaice spawn now-a-days in the northern and north-eastern Kattegat. A small part of these plaice belong to the Baltic plaice, whilst the greater part of them belong to the North Sea race.

The Baltic plaice have their most important spawning places in the relatively salt bottom water in the following localities:—

[1]) According to K. A. Andersson.

[2]) See H. M. Kyle (1900), A. C. Johansen (1910), Georg Duncker (1913) and Ludwig Keilhack (1913).

1) The Southern Kattegat with the Sound ...	salinity of water about			25—32	per mille
2) The Belt Sea	—	—	—	20—30	—
3) The Western Baltic.....	—	—	—	16—23	—
4) The Arcona Basin.....	—	—	—	12—16	—
5) The Bornholm Basin.....	—	—	—	10—16	—

The salinity given above refers to the mean salinity of the water at the bottom during the main spawning period of the Baltic plaice, i. e. in January, February and March. Plaice do not appear to spawn in water of lower salinity than about 10 per mille.

The spawning of the Baltic plaice takes place in the main in the months of January, February and March (A. C. Johansen 1911). A few plaice spawn — at any rate in certain years — already in November and December (J. Reibisch 1899, C. G. Joh. Petersen 1903), but spawning does not as a rule take place to any great extent before January and sometimes not until February (Strodtmann and Langhammer 1925). Spawning reaches its maximum in February or March and ceases in the Kattegat, the Belt Sea, and the Western Baltic in April. In the Bornholm Deep the spawning period lasts longer than in the more western parts of the Baltic. Trybom showed that in this region spawning plaice were found already in October (1901), and in November (1902) he found floating plaice eggs in the deep and salt water layers in the Bornholm Deep (G. Ekman, O. Pettersson, F. Trybom 1910). The main spawning in this region takes place no doubt in the months February—April and spawning still continues in May. During investigations on plaice in the Bornholm Deep in June Molander found that all the mature fish were spent (A. R. Molander 1925), neither has the present writer found ripe plaice in the Bornholm Deep in the summer months, whereas Strodtmann on the other hand has mentioned the finding of a few ripe plaice in the months June—October (S. Strodtmann 1908). For a long time it was regarded as uncertain to what extent larvae emerged from the eggs of plaice etc. found in the Bornholm Deep, or to what extent the eggs perished from want of oxygen etc. After the finding in the Bornholm Deep, during the Danish investigations at the beginning of May 1908, of numerous plaice larvae which on an average were smaller than those which were found at the same time in the Arcona Basin and the Western Baltic, it was clear that larvae emerge from these eggs at any rate in certain years (A. C. Johansen 1908), and the finding of numerous bottom stages of the younger year classes of plaice off the German coasts between Swinemünde and Stolpmünde indicates that the plaice stock in the Bornholm Deep is of no slight importance for the renewal of the stock in this part of the Baltic (H. Heidrich 1927). Young bottom stages of plaice (0-Gr.) have also been observed in fairly considerable numbers on the German coasts off Kolberg and Stolpmünde (E. Fischer 1927) and off the southern and eastern coasts of Bornholm (H. Blegvad 1928).

The distribution of the Baltic plaice extends from the northern Kattegat through the Belt Sea to the inner part of the Baltic proper. It does not extend to the Gulf of Bothnia nor in a general way to the north of 57° N. Lat. It is only of importance to the fisheries in the following localities:—

1) The Kattegat and Sound.
2) The Belt Sea, including the Western Baltic.
3) The western part of the Baltic proper as far as 18° E. Long. and 56° N. Lat.

In the Kattegat the plaice stock is highly mixed. In its northern and north-eastern parts the proportion of the stock belonging to the North Sea race is altogether predominant. In Aalborg Bay and the southern and south-western Kattegat (to the south of the line Anholt Lighthouse—Falkenberg) the Baltic plaice is usually predominant. In the Sound and the northern part of the Belt Sea, although the North Sea plaice make their way into them, the Baltic plaice are in an overwhelming majority (A. C. Johansen 1910). Various circumstances point to the probability that the North Sea plaice may — in small numbers — make their way down into the Western Baltic and the Baltic proper.

The plaice stock in the Belt Sea, the Sound, and the Baltic is thus renewed almost exclusively by the Baltic plaice, and it may be assumed that also the Baltic plaice in the Kattegat are of some importance as regards the renewal of the stock in the above mentioned waters, especially in the Sound and the Belt Sea. A series of fishing experiments have namely shown that many more plaice larvae are found in the southernly salt bottom current in the Kattegat and Belt Sea than in the northernly freshwater surface current. Similarly it is probable that more plaice larvae are borne with the current from the Kattegat and the western Baltic into the Baltic proper than in the reverse direction (J. P. Jacobsen and A. C. Johansen 1908, A. C. Johansen 1908).

The stock of Baltic plaice has undergone great changes during the last decennaries in consequence of an intensive fishery with Danish seine and otter seines (Skovlvaad), the numbers of sexually mature plaice having been materially decreased, first in the Kattegat (from 1880 and onwards), then in the Belt Sea and the Western Baltic (after 1899), and finally in the Baltic proper (after 1922). As a consequence of this fishery, the number of spawning plaice in the southern Kattegat, Belt Sea and Baltic is at the present time only a small fraction of the number which spawned there in former times, e. g. in the eighties of last century. By reason of the thinning out of the stock, the growth of the plaice has increased greatly in the southern Kattegat, Belt Sea and the western part of the Baltic proper, and the average size of the spawning plaice is now considerably larger than formerly. In spite of this, the quantity of plaice eggs produced by the Baltic plaice in the course of one spawning period has been greatly reduced in the last 25 years.

The question now presents itself as to whether a perceptible decrease in the quantity of plaice fry has taken place simultaneously with the decrease in the number of eggs produced.

In order to throw light on this question we will consider the results of an investigation which has been carried out on the variations in the quantity of the young bottom stages of plaice in the southern Kattegat and Belt Sea in the years 1904—14, and 1919—27. In this investigation the same gear was utilized in each year, and the results are given in Fig. 1 and Fig. 2 (A. C. Johansen 1927, Anton Fr. Bruun 1927). If we consider the curve of capture for the two periods, during which the investigations took place,

Fig. 1. Variation in the catch per hour of young plaice of 0-Gr. in the Southern Kattegat and Belt Sea, compared with deviations from mean salinity of surface water at Schultz's Grund Lightship during the year 1904—1927.

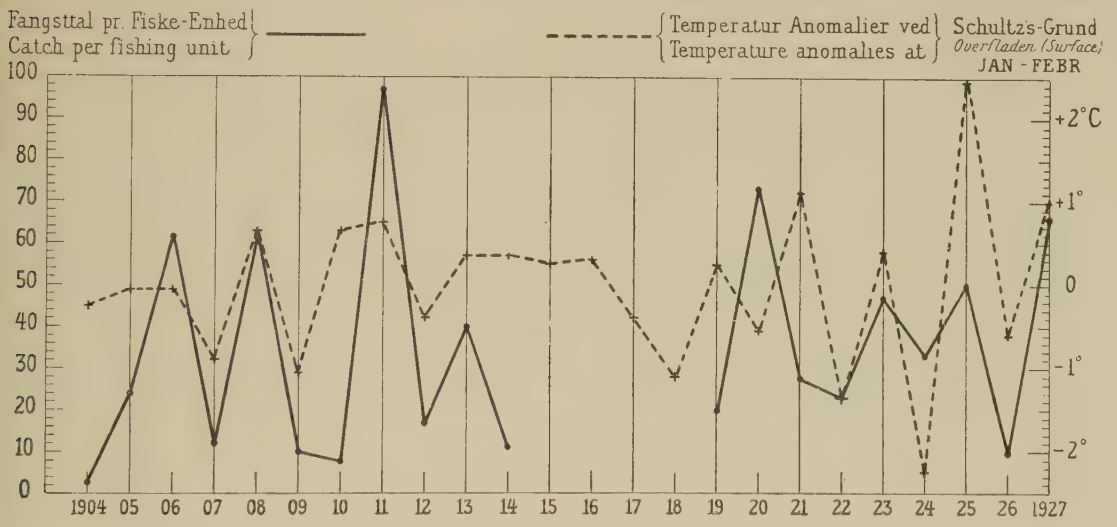

Fig. 2. Variation in the catch per hour of young plaice of 0-Gr. in the Southern Kattegat and Belt Sea compared with deviations from mean temperature of surface water at Schultz's Grund Lightship during the year 1904—1927.

i. e. 1904—14 and 1919—27, we get the impression that on an average about the same number of plaice of the 0-group per unit of fishing were caught in the latter period as in the former, whilst there can be no doubt that many more plaice eggs were produced per spawning season in the former period than in the latter (cp. Kramp 1924). We can accordingly regard it as highly probable that the quantity of plaice fry in the bottom

stage which is produced in any given season at any rate does not decrease to the same extent as does the quantity of plaice eggs. There is reason to assume that the quantity of plaice fry which survives the pelagic stage is highly dependent on the amount of nourishment in the water during a certain period in this stage and that again both the temperature and the salinity influence the amount of nourishment available. The range of action of the young plaice larvae is very small. (See Fig. 1 and Fig. 2).

In carrying out the fishing experiments, the results of which are given in Fig. 1, greater experience in the use of fishing gear has been gained in the course of years, so one may assume that under otherwise similar conditions a somewhat greater number of fish would be caught per unit of fishing in the latter period than in the former. The fact that the highest figure for the catches was reached during the former period (1911), and that the figures for the four relatively abundant years in the former period (1906, 1908, 1911 and 1913) were on an average slightly higher than the figures for the four relatively abundant years in the latter period (1920, 1923, 1925 and 1927) renders it therefore fairly probable that some decline has taken place in the production of the young bottom stages of plaice. If this should be the case it is the more deplorable, seeing that just at the present time when the stock of old mature plaice in the Baltic has been greatly thinned out there is room and food for many more young fish than in former times.

c. Price of plaice landed in Denmark from the Belt Sea and the Baltic during the different months of the year.

During spawning and for some time after, the plaice is, as is well known, very meagre[1]) and this greatly affects its market value. As will be seen from Tables 5—7, the prices for Baltic plaice in the Belt Sea, the Western Baltic, and the Arcona Basin are relatively low in the months December—May and relatively high in the months June—September. In the case of the Belt Sea, the average price for the months July, August, and September exceeds by 29 per cent. the average price for February, March and April. The corresponding percentage for the Western Baltic is 116, whilst for the Arcona Basin the price in July—August exceeds the price in December—March by about 100 per cent.

It will thus be seen that there are great differences in price, and since the plaice remain in the waters in question throughout the year, and since in the countries bordering on these waters there is ample fishing gear for fishing as much in the summer alone as the stock can bear, this is a powerful argument for a close season in winter.

As regards the plaice caught in the Bornholm Deep, the fluctuations in price differ from those for the waters mentioned above. The prices for plaice are in this case relatively high during the winter and relatively low during the summer (Table 8). The explanation for the very low prices prevailing during the summer is that plaice usually

[1]) For information on the state of nutrition amongst the Baltic plaice at the different seasons of the year, see for instance S. Strodtmann (1908) and S. Strodtmann and H. Langhammer (1925).

die shortly after capture owing to their being brought up from a relatively low to a relatively high temperature. Since the fish are not as a rule iced immediately after capture, they rapidly become uneatable. The relatively low prices for plaice from the Bornholm Deep throughout all the months of the year point to the fish being of a lower quality than those from the Belt Sea and the Western Baltic. The low price of the Bornholm plaice may, however, also be accounted for to some extent by the fact that a number of the fish are below the general Danish size limit of 25.7 cm., for which reason they are marketed in Germany.

Table 5. Price per Kilogramme in Øre for Plaice taken in each month in the Belt Sea. (The table refers to the total Danish catch in the Belt Sea exclusive of the Western Baltic).

	1924	1925	1926	Mean[1]) 1924—26
January	90	92	82	88
February	102	86	70	86
March	85	91	69	82
April	90	95	71	85
May	97	106	79	94
June	107	123	84	105
July	113	124	90	109
August	116	118	94	109
September	115	110	90	105
October	113	96	90	100
November	110	93	97	100
December	118	83	88	96
Yearly average	105	103	83	97

Table 6. Price per Kilogramme in Øre for Plaice taken in each month in the Western Baltic and landed in Bagenkop in 1923—26. (The main part of the Danish catch of plaice in the Western Baltic is landed in Bagenkop).

	1923	1924	1925	1926	Mean[1]) 1923—26
January	80	110	120	80	98
February	75	130	90	85	95
March	70	110	85	60	81
April	52	75	80	50	64
May	115	95	139	100	112
June	150	140	175	110	144
July	150	195	200	130	169
August	165	175	200	140	170
September	200	186	180	150	179
October	125	160	120	130	134
November	120	130	100	125	119
December	100	150	80	100	108
Yearly average	100	117	113	86	104

[1]) The means are averages for the prices given for each of the years stated.

Table 7. Price per Kilogramme in Øre for Plaice taken in each month in the Arcona-Basin and on the slopes East of Sealand, Möen and Falster and landed in Copenhagen in 1923—26.

	1923	1924	1925	1926	Mean[1]) 1923—26
January	..	..	..	..	..
February	..	..	..	..	..
March	45	..	50	83	59
April	61	92	81	47	70
May	76	72	86	74	77
June	91	93	113	83	95
July	84	93	125	83	96
August	98	85	126	90	100
September	77	86	71	92	82
October	58	85	62	88	73
November	48	55	60	79	60
December	41	49	56	80	56
Yearly average	79	84	97	80	85

Table 8. Price per Kilogramme in Öre for Plaice taken in each month in the waters round Bornholm — by Bornholm fishermen in 1923—27.

	1923	1924	1925	1926	1927	Mean[1]) 1923—26
January	..	50	40	31	30	40
February	60	41	38	30	33	42
March	50	50	31	20	30	38
April	48	50	36	20	30	38
May	42	35	31	19	30	32
June	42	30	38	30	35	35
July	36	35	41	31	30	36
August	44	40	12	31	50	32
September	51	40	30	30	50	38
October	60	44	31	30	34	41
November	42	45	31	40	40	40
December	40	46	30	30	32	36
Yearly average	44	42	33	28	33	37

d. The quantity and value of the Danish catch of plaice in the Belt Sea and Baltic in the different months of the year.

In Tables 9—12 information is given concerning the quantities of plaice landed in the different months of the year. In the Belt Sea the catches were greatest in the months May—August and least in the months September—December. In each of the months January, February, March and April the catches constituted 7—8 per cent. of the year's total catch (Table 9).

In the Western Baltic the Danish catch is greatest in the months January,

[1]) See foot-note Table 5.

February, and March. Over half the annual catch is taken during these three months, i. e. during the main spawning period of the plaice and at a time of the year when the price is relatively low (Table 10).

In the Arcona Basin there is little fishing by Danish fishermen in the months of January, February, and March. The chief fishing takes place in the months May—September.

It should be noted that Table 11 does not give the total Danish catch of plaice in the Arcona Basin and on the western slopes of the Baltic, but only the number of those landed in Copenhagen, which constitute about half the total catch.

Table 9. Quantity of Plaice in Kilogrammes taken in each month in the Belt Sea (exclusive of the Western Baltic) in 1924—26.

	1924	1925	1926	Mean 1924—26 Kgs.	per cent.
January	30607	105306	79142	71685	7.3
February	50525	103289	86373	80062	8.1
March	93662	74947	74610	81073	8.2
April	83540	68783	59277	70533	7.2
May	114744	82537	92384	96555	9.8
June	114060	100285	106160	106835	10.9
July	144591	116469	108299	123120	12.5
August	122418	110303	97109	109943	11.2
September	60008	77104	57778	64963	6.6
October	70134	78104	50088	66109	6.7
November	58701	64257	50030	57663	5.9
December	64488	60781	39680	54983	5.6
Total[1])	1,007478	1,042165	900930	983524	100.0

Table 10. Quantity of Plaice in Kilogrammes taken in each month in the Western Baltic and landed in Bagenkop in 1923—26.

	1923	1924	1925	1926	Mean 1923—26 Kgs.	per cent.
January	40000	21900	40500	32000	33600	15.5
February	52000	33000	43250	45500	43438	20.4
March	37200	62500	12200	47200	39775	18.6
April	11400	45000	5000	11500	18225	8.5
May	8150	16000	7200	15100	11612	5.4
June	9650	4000	3700	9400	6688	3.1
July	10200	5197	3917	7015	6582	3.1
August	11800	7932	11500	6238	9368	4.4
September	12000	4554	3000	2700	5564	2.6
October	13800	3400	3000	1500	5425	2.5
November	13000	13500	19000	10200	13925	6.5
December	22000	27000	18000	10000	19250	9.0
Total	241200	243983	170267	198353	213451	99.6

[1]) The figures differ — but not essentially — from those in the official Danish statistics.

Table 11. Quantity of Plaice in Kilogrammes taken in each month in the Arcona Basin and on the slopes East of Sealand, Möen and Falster and landed in Copenhagen in 1923—26.

	1923	1924	1925	1926	Mean 1923—26 Kgs.	Mean 1923—26 per cent.
January	..	..	..	..	..	..
February	..	..	..	..	..	..
March	4700	..	700	1950	1838	0.5
April	18645	6000	9625	21155	13856	4.1
May	56955	62190	33550	47690	50096	14.7
June	52685	72965	47580	30245	50869	14.9
July	60355	92676	35365	24430	53206	15.6
August	106955	109600	36410	42770	73934	21.6
September	78080	45585	37100	29965	47682	14.0
October	40085	31355	20200	10050	25422	7.4
November	30800	38175	13350	1575	20975	6.1
December	6675	7625	950	250	3875	1.1
Total...	455935	466171	234830	210080	341754	100.0

Table 12. Quantity of Plaice in Kilogrammes taken in each month in the waters round Bornholm by Bornholm fishermen in 1923—27.

	1923	1924	1925	1926	1927	Mean 1923—26 Kgs.	Mean 1923—26 per cent.
January	..	54700	82700	62900	63300	50075	6.0
February	2000	26050	89100	55700	92900	43212	5.3
March	5000	27800	169100	91500	54000	73350	8.8
April	13300	100500	173700	74000	101400	90375	10.9
May	69500	88000	133920	123100	73700	103630	12.5
June	59100	72500	96900	92500	79750	80250	9.7
July	31900	76900	32400	40000	50700	45300	5.5
August	78200	65500	50300	35500	34400	57375	6.9
September	32600	57100	38000	31200	23800	39725	4.8
October	28400	113000	56600	68000	10700	66500	8.0
November	31900	189900	101000	95300	24000	104525	12.6
December	25600	121600	92900	62000	15100	75525	9.1
Total..	377500	993550	1,116620	831700	623750	829843	100.1

In the waters around Bornholm fishing is carried on to a fairly great extent at all seasons of the year, and the average percentage of the annual catch landed in Copenhagen, for the first months of the year varies from 5.3 for February to 8.8 for March for the years 1923—26 (Table 12).

Tables 13—16 give information concerning the value of the plaice caught in the different months of the year.

In the Belt Sea the value of the catches in each of the first four months of the year constitutes between 6 and 7 per cent. of the total annual value. The maximum value of the catches in these waters is reached in July, and the next greatest values in August, June and May (Table 13).

In the Western Baltic the value of the catches is greatest in January, February and March. These three months combined account for 47.6 per cent. of the value of the total annual catch (Table 14).

In the Arcona Basin the maximum value of the catches is reached in August, and the next greatest values in July, June, September and May. During the winter Danish fishing in the Arcona Basin is of little importance.

In the waters around Bornholm the values of the catches in January, February and March constitute respectively 6.7, 5.3 and 7.3 per cent. of the value of the total annual catch. The value of the catches is greater in the months April—June and October—December (Table 16).

Table 13. Value in Kroner of the Danish catch of Plaice taken in each month in the Belt Sea (exclusive of the Western Baltic) in 1924—26.

	1924	1925	1926	Means 1924—26 Kgs.	per cent.
January	27456	96546	64773	62925	6.5
February	51441	88498	60296	66745	6.9
March	79718	68243	51287	66416	6.9
April	75582	65621	42318	61174	6.4
May	111474	87633	73152	90753	9.4
June	122261	123692	88849	111601	11.6
July	163054	144559	97682	135098	14.0
August	141471	129849	91028	120783	12.6
September	68937	84973	52087	68666	7.1
October	79157	75014	45026	66399	6.9
November	64706	59565	48608	57626	6.0
December	75938	50446	34958	53781	5.6
Total...	1,061195	1,074639	750064	961967	99.9

Table 14. Value in Kroner of the Danish catch of Plaice taken in each month in the Western Baltic and landed in Bagenkop in 1923—26.

	1923	1924	1925	1926	Mean 1923—26 Kgs.	per cent.
January	32000	24090	48600	25600	32572	14.7
February	39000	42900	38925	38675	39875	17.9
March	26040	68750	10370	28320	33370	15.0
April	5928	33750	4000	5750	12357	5.6
May	9372	15200	10000	15100	12418	5.6
June	14475	5600	6475	10340	9222	4.2
July	15300	10134	7834	9119	10597	4.8
August	19470	13881	23000	8733	16271	7.3
September	24000	8465	5400	4050	10479	4.7
October	17250	5440	3600	1950	7060	3.2
November	15600	17550	19000	12750	16225	7.3
December	22000	40500	14400	10000	21725	9.8
Total...	240435	286260	191604	170387	222172	100.1

Table 15. Value in Kroner of the Danish catch of Plaice taken in each month in the Arcona Basin and on the slopes East of Sealand, Möen and Falster and landed in Copenhagen in 1923—26.

	1923	1924	1925	1926	Mean 1923—26 Kgs.	per cent.
January	..	..	..	..	..	..
February	..	..	..	..	..	..
March	2135	..	350	1620	1026	0.4
April	11355	5510	7816	10025	8676	3.0
May	43477	44733	28852	35309	38093	13.3
June	47849	67982	53968	24972	48693	17.0
July	50645	86080	44167	20249	50285	17.5
August	104882	93024	46040	38582	70632	24.6
September	60470	39307	26306	27634	38429	13.4
October	23271	26543	12577	8891	17820	6.2
November	14743	20916	8004	1251	11228	3.9
December	2733	3755	530	200	1804	0.6
Total...	361560	387850	228610	168733	286688	99.9

Table 16. Value in Kroner of the Danish catch of Plaice taken in the waters round Bornholm by Bornholm fishermen in 1923—27.

	1923	1924	1925	1926	1927	Mean 1923—26 Kgs.	per cent.
January	..	27210	32680	19610	18840	19875	6.7
February	1200	10565	33840	16710	31010	15579	5.3
March	2500	13900	51830	18750	16200	21745	7.3
April	6380	50070	61680	14800	30430	33232	11.2
May	28900	30775	41456	23920	21920	31263	10.6
June	24860	21800	36510	27750	27595	27730	9.4
July	11570	26995	13180	12415	15350	16040	5.4
August	34385	26200	5870	11015	17200	19368	6.5
September	16670	22890	11400	9360	11880	15080	5.1
October	17040	49605	17530	20400	3660	26144	8.8
November	13460	85455	30950	38120	9600	41996	14.2
December	10300	55865	28325	18600	4840	28272	9.5
Total...	167265	421330	365251	231450	208525	296324	100.0

e. The period for which it is proposed that the close season should be in operation in the Belt Sea and the Baltic.

The proposed period for the closure extends from January 15th to April 15th, i. e. for three months of that period during which both price and quality are low. (See Chapters b and c). This period also includes the most important part of the spawning season for plaice. It is true that as a rule more plaice in the Belt Sea and Baltic spawn in the first half of January than in the first half of April, but on the other hand the plaice larvae which develop in the spring have presumably a better chance of obtaining sufficient food than the larvae which develop in the severest part of the winter. The

circumstance that the quality of the plaice, and also on an average their price, is lower in April than in January, speaks then in favour of a close season in the first half of April rather than in the first half of January (Chapter b).

As has been seen in Chapter d, a three months' close season during the winter will have a marked effect on the fishing industry since the winter accounts for a considerable percentage of the value of the annual catch. As regards Denmark, the percentage of the value of the annual catch of plaice which is derived from the period during which closure is proposed, is calculated to be as follows:—

For the Belt Sea	20	per cent.	approximately
For the Western Baltic	43	—	—
For the Baltic proper	15	—	—

The fishermen will thus suffer no slight loss, but with the existing large fishing material the loss should be covered in the course of a few months after the cessation of the closure and profits earned. It must also be emphasized that even if the plaice are protected during the winter, the fishermen in the Belt Sea and Baltic have other fisheries to fall back upon, first and foremost the cod fishery. Fishing for flounders, dabs, and turbot will also no doubt in several localities prove remunerative during the winter. All these species of fish spawn later in the year than the plaice, and during the first months of the year their quality is consequently not so low as is that of the plaice.

f. The area within which it is proposed that the close season for plaice should be enforced.

The area for which it is proposed to introduce a close season for plaice comprises the entire Baltic, the Sound, and the Belt Sea. The lines Gilbjerghoved—Kullen and Gniben—Hasenøre form the northern boundary of this area. The proposed closure would thus not be in operation throughout the whole region where the Baltic plaice are of importance for the fishery and where they have important spawning places, since the southern and western Kattegat lies outside the area proposed for closure. That the southern and western Kattegat is not included in this proposed area is due amongst other reasons to the following circumstance:—

A fishery is carried on from large steam trawlers in the southern Kattegat, particularly by German fishermen, which is based partly on plaice, partly on other species of fish, such as cod, haddock, sole, turbot and brill. It cannot be assumed that plaice captured by these trawlers could be liberated again in a lively condition. In the Belt Sea, the Western Baltic, and the Baltic proper, fishing is only very exceptionally carried on from large steam trawlers.

The question ought, however, to be taken up for consideration as to whether an international embargo should not be laid in the future on the use of steam trawlers and large motor trawlers in the southern and western Kattegat (as well as in the Belt Sea and the Baltic), and a close time for plaice introduced in the southern and western Kattegat of the same duration as that proposed for the Belt Sea and the Baltic. The quality of the plaice in the southern and western Kattegat is also on an average lower

in winter than in summer, and the average price for plaice caught in these waters is about 30 per cent. higher in the months May—August than in the months January—March.

Tables 5, 6, 8, 9, 10, 12, 13, 14 and 16 have been compiled on the basis of data received from the Fishery Board (Fiskeridirektoratet) in Copenhagen, whilst Tables 7, 11 and 15 are derived from data in the official Danish Fiskeri-Beretning.

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4. The state of the plaice fishery in the Western Baltic and the Baltic Proper.

By

S. Strodtmann.

The complaints of fishermen that the quantity of fish is decreasing have been heard no doubt as long as fishery has been in existence. The productiveness of fishery has been always dependent on greater or lesser natural fluctuations and in the years when the progeny is less than normal louder complaints are at once regularly to be heard from the fishermen, whereas on the other hand increases in the yield are regarded quite as a matter of course. This has been the case for the last 50 years with the plaice and flounder fisheries. It is therefore very necessary to investigate whether the complaints about the decline in the fishery are only due to a passing phase or to a lasting state of affairs. If the latter is the case we must attempt to remedy this decline by suitable measures of protection. I will attempt to throw light on this question on the strength of the data obtained from investigations.

a. Total catch of flounders and plaice and the proportional composition of the catch in the entire Baltic Area.

In the following table a summary is given of the catches of plaice and flounders in the Baltic Area for different years, the adjacent column showing what percentage of the whole the plaice constitute. The areas to the east of Pomerania are left out of account since owing to the loss of a great portion of West Prussia the present figures afford no comparison with the pre-war figures. The entries are taken from the Vierteljahrshefte zur Statistik des deutschen Reiches.

The first glance at these statistics seems to disprove directly any decrease in the flatfish stock in the Baltic. The total has risen from 5,780,000 kg. in the year 1913 to 8,750,000 kg. in the year 1926, i. e. by more than 50 per cent., the greater part of the increase being due to the plaice, of which in 1926 over 230 per cent. more were caught than in 1913. Nevertheless these increased catches can not be ascribed to an enlargement of the stock. For the following facts must be taken into account.

1) The intensity of the fishery has increased still more than the increase in the catch. The former fixed net fishery, a comparatively mild form of fishing, has been quite ousted in most localities. Its place has been taken by the trawling fishery, and more-

Table 1. Weight in 100,000 kg., the adjacent column showing what percentage of the whole catch of the two flatfish species the plaice constitute.

	1913		1920		1921		1922	
Plaice	12.1	20.9	14.9	21.3	12.5	17.0	12.5	18.1
Flounder	45.7	..	55.1	..	61.0	..	56.4	..
Total	57.8	..	70.0	..	73.5	..	68.9	..

	1923		1924		1925		1926	
Plaice	25.9	29.4	19.1	26.2	23.4	32.8	28.4	32.5
Flounder	62.0	..	53.7	..	48.0	..	59.1	..
Total	87.9	..	72.8	..	71.4	..	87.5	..

over with increasingly powerful motors and bigger nets. In consequence, not only are the old fishing centres near the coasts subjected to a more intense fishery but wide stretches of the open sea are also visited which hitherto enjoyed complete immunity.

2) The fish caught at the present time are on an average larger than formerly. The increase in mean length of the captured fish varies from 4 to 10 cm. for the plaice in the Western Baltic according to the region, and amounts in the Bornholm Basin to 6—7 cm. for the plaice and about 4 cm. for the flounder. This means that the number of the fish caught where the weight remains the same is now considerably smaller. Thus for instance in 1906 off Bornholm, 100 kg. comprised 1000 plaice but in 1925 only about 450. When we take this fact into consideration we are surely justified in drawing the conclusion that the number of captured fish has not on the whole greatly increased. On the contrary, the increase in size of the fish tends to show that the stock has been thinned. It is a well known fact that the fish grow more rapidly and better when they are not too dense as the amount of food available for each is then greater.

3) Finally it must be borne in mind that the accuracy of the statistics has increased in the course of years. This is especially the case as regards the plaice. Formerly the majority of the plaice in the Baltic proper disappeared in the statistics under the general term "flounders". Not until recent years has a change taken place in this respect. But also in general the formation of numerous new fishery associations has rendered it possible to estimate the catches more accurately than formerly, when it was very difficult to obtain a general estimate of the catches of the many individual fishermen.

In spite however of these considerations, even if the number of the fish has perhaps not increased to the same extent as the catch we must point out that throughout the whole Baltic Area a greater yield by weight of flatfish is now obtained from Germany than formerly and that, through the average size having risen appreciably, the catch has become still more valuable.

b. Fishing in the separate areas.

When we turn to the fishery in the separate parts of the Baltic we are confronted by other conditions. Also the following table is based on the figures of the German Reichsstatistik, but we repeat that the latter can lay no claim to great accuracy, nor does the place of landing invariably indicate that the fish originate from that area, but an approximate estimate is nevertheless provided by these figures.

Table 2. Weight in 100,000 kg.

	1913	1920	1921	1922	1923	1924	1925	1926
Plaice								
Kiel Bay & Lübeck Bay....	**9.87**	4.37	4.03	3.1	3.0	2.3	1.32	1.05
Mecklenburg Bay.....	1.87	**7.73**	**5.09**	**4.68**	3.07	1.62	2.87	2.77
West Pomerania.....	0.18	2.77	2.53	4.35	**19.46**	**10.7**	**17.11**	**17.12**
East Pomerania	0.13	..	0.82	0.39	0.39	4.45	6.53	7.43
Flounder								
Kiel, Lübeck, Mecklenb. Bays	4.76	2.61	1.93	2.41	1.61	1.37	1.72	2.61
West Pomerania.....	18.04	23.04	**31.41**	**33.16**	**41.97**	**34.12**	**39.2**	23.86
East Pomerania	22.9	29.48	27.68	20.84	18.38	18.21	22.88	**32.75**

Prior to the war, the coast of Schleswig-Holstein was the most important place for the capture of plaice, more than three quarters of the total catch in the Baltic being caught there. In 1920 the catch decreased by more than the half, and 1926 produced about a tenth of the 1913 yield. Furthermore the statistics are based on the fish landed. Whereas however formerly fish were only landed from the adjoining area of the sea, in recent years the landing of fish caught in other areas has more and more increased. The decline in the yield is thus far more catastrophic than would appear from the statistics. In actual fact the plaice fishery in Kiel Bay and Lübeck Bay which was once so flourishing has now completely succumbed.

On the other hand, other fishing centres have gained in importance. In the year 1920 Mecklenburg Bay occupied the foremost place. As the catches off the Schleswig-Holstein coasts decreased, the fishermen using motor vessels turned further eastwards, the areas to the east of Fehmarn and above all to the south of Møen and west of Rügen being intensively fished. Here there was still an old accumulated stock, which at first yielded a rich harvest. Warnemünde was the main landing place and the quantity of fish brought thither increased enormously. But in a short time the stock was depleted, already in 1923 not even the half of the 1920 catch was obtained and in 1924 not even a quarter. In 1925 and 1926 the more intensive exploitation of the Arcona Basin, from which region part of the catch was landed in Warnemünde, brought about another slight rise, but on the whole the yearly accretion to the stock by growth by no means kept pace with the intensity of fishing. The majority of motor fishing vessels left the area in 1923 and made their way further eastwards. Warnemünde lost its importance as the

chief landing harbour, and Sassnitz took its place. In 1923 the fishery to the east and north of Rügen, especially on the Oder Bank and the Adler Ground, yielded quite enormous numbers of plaice; the record figure was 1,946,000 kg., which was never again reached in the following years. Nevertheless this region still remained the most important, yielding more than all the others. The enormous catch obtained here raises the question as to whether the only cause was the fishing of new, previously unnoticed grounds or whether a change had not taken place in the composition of the fish stock. The latter seems probable especially as the stock was not merely old and accumulated but consisted largely of young fish. The plaice have undoubtedly become more numerous in this region. Our investigations in the Bornholm Basin have also shown that the plaice plays a much greater part as food fish than 20 years ago. Not only has the total number increased but also still more the total weight, the fish being on an average larger. The causes of this increase in the stock are not yet clear. It may have been occasioned by a greater immigration of young fish, or by more favourable conditions for propagation in this region, or perhaps by both. We have not succeeded, it is true, in finding the 0-group in this region of the sea in large numbers, whereas all the other year classes are abundantly represented. It is consequently not yet certain whether all the fish in this region have passed through all the stages of development. If this is not the case, an immigration must have taken place, largely of very young fish. In any case all the conditions of life in the Baltic proper must have changed, which can also be seen from the behaviour of other fish, e. g. the dab. The hydrographical conditions are here undoubtedly responsible to some extent. The stronger salt currents which during the last ten years have flowed into the Baltic have changed the biology of both the fish and the food animals. But despite the now more favourable conditions of life for the plaice, the latter will not be able in the long run to bear such fishing as took place in 1923. Already in 1924 the yield sank by one half. In 1925 and 1926 a slight rise, it is true, occurred, but this was due to the fact that new grounds were again discovered further eastwards. In these years the so-called Bornholm fishery commenced on a large scale. In the winter and spring months, February to April, great numbers of spawning plaice and flounders collect as is well known in the Bornholm Deep, and these fish, of little intrinsic value were now captured in large quantities and thrown on the market. In recent years large numbers of plaice have also been captured off the coasts of East Pomerania. Here, it is true, we have no statistics to rely on, as prior to 1924 no accurate distinction was drawn between plaice and flounders. Thus the German statistics for East Pomerania in the year 1922 records only 39,000 kg., whereas according to HENKING's investigations the landings of plaice in the three most important harbours of East Pomerania, Kolberg, Rügenwaldermünde, and Stolpmünde amounted to at least 250,000 kg. But the yield has certainly risen appreciably in recent years, largely owing to the increased Bornholm fishery.

In this connection the flounder fishery may be briefly mentioned: in the actual Western Baltic it is devoid of importance. Also in Mecklenburg not many were landed, the fish originating mostly from the regions to the east of Gedser to the Arcona Deep. In Pomerania other conditions prevail. Here the flounder is of the greatest importance.

The highest yields in 1913 and 1920 were obtained by East Pomerania, during the years 1921—1925 by West Pomerania, and finally in 1926 again by East Pomerania. The high figures of the flounder catches during the years after the war must be ascribed solely to the intensive fishing, for as our fishing experiments in the Bornholm Basin proved, the stock of fish has greatly decreased in numbers although, as in the case of the plaice, the average length has increased. The favourable results obtained by East Pomerania in 1926 are likewise due to the Bornholm fishery which was particularly intensive in that very year.

c. The fishery during the separate seasons and the prices of fish.

In many respects it is of importance to ascertain the catches for the separate seasons and the prices paid for the fish.

The following table gives a summary of the catches in each month of the years 1924 and 1926. The figures which are again taken from the German Reichsstatistik refer to the catches for the entire Baltic, as the figures for the separate areas are unfortunately not available. The weights are again given in hundreds of metric tons (100,000 kg.).

	January		February		March		April		May		June	
	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder
1924.....	0.35	0.05	0.07	0.01	0.59	0.2	0.46	1.85	1.79	7.21	2.85	8.13
1926.....	0.4	2.85	0.84	3.37	1.16	3.53	2.41	4.76	3.33	6.27	4.52	8.84

	July		August		September		October		November		December	
	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder
1924.....	3.2	10.26	3.83	9.54	2.37	7.17	1.98	6.23	1.1	2.38	0.49	3.66
1926.....	3.82	7.22	2.78	4.84	2.93	5.11	3.67	7.65	1.94	4.05	0.6	3.42

The two years 1924 and 1926 are compared because 1924 was the last before the intensive Bornholm fishery began whereas in 1926 it was at its full height. It is especially striking how small the catches were in the first months of 1924, i. e. 147,000 kg. plaice and 211,000 kg. flounders for the months January—April. In 1926 on the other hand during the same months 481,000 kg. plaice and 1,491,000 kg. flounders were caught! Now the fish caught in this season are generally in a poor state of nutrition and are either spawning or have just spawned! When we compare the catches in the summers of the two years, June—September, when the fish are generally in a good state of nutrition, we find that 1926 with its 2,601,000 kg. was distinctly inferior to 1924 with its 3,510,000 kg. The total excess of the 1926 figures over those for 1924 is thus to be ascribed first and foremost to the heavy fishing in the spring, i. e. the Bornholm catches.

According to the German Reichsstatistik, the following average monthly prices were obtained for plaice and flounders in the entire Baltic:

Monthly average prices in pfennigs per kilogram.

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Plaice.....	1924	52	47	40	41	31	40	35	28	35	30	37	38
	1926	53	34	**27**	**24**	30	30	42	41	43	38	31	34
Flounders .	1924	37	27	32	25	20	21	25	24	24	19	18	22
	1926	22	20	**16**	**15**	18	19	25	29	33	28	22	22

The prices are subjected to many fluctuations which are not evident from a mere numerical table, being caused mainly by the size of the supply and the quality of the fish. But although these average prices are those for the entire Baltic, the effect of the Bornholm fishery is nevertheless to be discerned in this table. In comparison with 1924, the year 1926 shows a great fall in prices for both plaice and flounders in the months of March and April. In 1924 the quantity of fish brought to market in winter was small, and accordingly in February and March comparatively high prices were obtained. In 1926, fishing in the Bornholm Basin began in February, and the fish marketed were still in comparatively good condition because spawning had not yet reached an advanced stage. A fall in the prices was however already perceptible. In March and April when the bulk of spent and emaciated fish reached the market, the prices sank to the lowest level for the whole year. The low prices fetched by the Bornholm fish are still more evident when we consider not the entire Baltic but one centre from which the Bornholm fishery is carried on with particularly great intensity. I give below the monthly average prices for plaice paid by the Fishery Association in Kolberg (Fischverwertungsgenossenschaft Kolberg) to fishermen in the years 1925 and 1926. These figures have been kindly placed at my disposal by the head of the Association, Herr Adamheid, to whom I tender my thanks.

Monthly average prices for plaice in pfennigs per kilogram.

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1925	Plaice I...	36	32	24	24	30	46	54	54	50	44	40	40
	Plaice II ..	20	16	10	10	14	22	36	30	30	26	28	26
1926	Plaice I...	36	38	20	20	32	48	54	54	54	44	40	36
	Plaice II ..	20	20	8	10	18	26	30	30	30	28	28	28

Also in this case the same conditions prevailed. In March and April the great fall in prices took place, being still greater in 1926 than in 1925 owing to the still further stage of development of the Bornholm fishery.

A summary is given below of the prices for plaice in 1925 and 1926 in yet another place which now took an active part in the Bornholm fishery. The Fishery Association in Stolpmünde paid their members the following prices:

Monthly average prices of plaice in pfennigs per kilogram.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1925	..	..	30	34	40	42	44	44	40	44	50
1926	50	50	26	16	28	36	44	46	48	44	40

In 1925 no fishing had taken place in January and February, but it commenced in March and April, the prices being low when compared with the other monthly prices. In 1926 the Bornholm fishery started in January and February; as the quantity was not yet large and the quality was still fairly good the prices remained rather high, but as the supply increased and the fish deteriorated a sudden fall in price occurred in March which also had an effect on the following May.

In the winters and springs of 1927 and 1928 the position as regards the prices became still more acute. The Berlin market could not absorb these large quantities of inferior fish; the prices sank to such an extent that expenses were hardly covered. A large proportion of the fish found its way to the fish-meal factories, the fishermen in this way receiving nothing whatever for their fish. The fishermen themselves also perceive the foolishness of this Bornholm fishery, and know that they are injuring themselves but no-one will be the first to stop because each one fears that a competitor may yet perhaps, if the supply declines, succeed in making a profit. In any case the majority of the fishermen desire a general prohibition of this winter fishery.

The sharp fluctuations in price do not affect all the size categories of plaice equally. The Baltic plaice are as a rule sorted into two categories. Size I should comprise fish of over 26 cm. and Size II over 22 cm. In many cases there is also Size I a for fish over 30 cm. and finally Size III for those under 22 cm. These measurements are however nowhere strictly kept to. The sorting is most accurate in East Pomerania, in Sassnitz the deviations in a downward direction are greater, still more so in Stralsund and above all in Swinemünde, nearly all plaice of 24—26 cm. being reckoned as Size I and of 20—21 cm. as Size II in these latter places. I give below some prices for plaice, especially from the area of the Pomeranian Bay for the months of September and October (Prices per kilogramme in Pfennigs).

	Plaice I	Plaice II
September 8th. Stralsund	50	20
September 8th. —	50	20
October 8th. Sassnitz.....	52	12
October 11th. Stralsund	52	32
August 31th. Kröslin.....	36	18
September 7th. —	36	16
September 13th.—	36	14
September 30th.—	36	10
October 9th. —	36	8
October 23rd —	36	16

We see that fluctuations of price occur in both size categories within a certain period but that whereas in Size I they are comparatively small, in Size II they vary by 100 per cent. or more within a few weeks. The reason for this is chiefly that the market

is only to a certain degree capable of absorbing these smaller fish. As soon as this limit is passed a great fall in price occurs. It is therefore to the interest of fishermen to avoid such a flooding of the market. The dealers have also perceived this and have attempted, by accepting only limited quantities and by fixing a size limit of 22 cm., to prevent an excessive supply of small plaice. As the fish in this case are chiefly young ones which would in a short time improve in quality, it is to the general interest of all connected with the fishing trade not to reduce their numbers too greatly. Unfortunately this size limit is not everywhere maintained. Its observance would be of particular advantage in the area to the east of Rügen and in the Pomeranian Bay because large quantities of young fish occur there.

Summary.

1) In Kiel Bay and Lübeck Bay the plaice fishery is quite ruined. The yield is now diminutive in comparison to what it has been.

2) In Mecklenburg Bay and the area between Falster, Møen, Rügen, and the German coasts, the fishery flourished for a short period, but since the accumulated stock has been depleted it is also here steadily decreasing. The only yield worth mentioning is now obtained from the Arcona Basin and the adjoining waters.

3) The chief plaice fishery is now to be found in the area to the east of Rügen. It has here developed enormously. The yield has not only made good the loss caused by the decrease in the western area but it now exceeds the total yield of the pre-war period. The coastal regions are, it is true, largely depopulated so that the fixed net fishery which was formerly of the greatest importance is now almost completely abandoned. On the other hand, thanks to the larger vessels and more powerful motors fishing grounds are being exploited farther and farther from the coast. In the last two years the winter fishery in the Bornholm Basin has in particular contributed to the rise in the yield. But serious signs of the decrease are also here in evidence. Apart from the fact that the coastal fishery, as already mentioned, has lost in importance in many localities in East Pomerania, the banks lying farther out to sea also produce a lower yield. This is the more remarkable since it is for the most part well nourished fish that are caught there in contrast to the winter catches in the Bornholm Basin. These winter catches will however also diminish within a short time for, as has been sufficiently proved by scientific investigations, the Bornholm Basin in its deep waters (over 70 m.) possesses practically no fish stock of its own. The plaice and above all the flounders which remain there in large numbers in February and March depart after spawning to shallower regions. During spawning their quality is bad, especially towards the end of the spawning period, and they consequently can only fetch low prices in the market. The fish caught during this period thus never reach the flat regions where it would otherwise have been possible to catch them in the summer in good condition. There is therefore no doubt that the heavy fishing of the Bornholm Basin in the spawning season greatly depopulates the good summer fishing grounds. It should however above all be noticed that the hitherto increasing yield of the fishery to the east of Rügen has been attained by the fishermen's constantly resorting to fresh fishing grounds and is not due to better results from the

old ones. By fishing the Bornholm Basin the limit has now been reached for at least the plaice, as far as any quantities available for fishing are concerned. For them there are no more fresh fishing grounds in the Baltic.

Yet another circumstance gives rise to apprehension: The region to the east and south-east of Rügen as far as and including the Oder Bank is definitely a young fish area for plaice and flounders. (Larger fish, it is true, also come here in the summer, the larger flounders visiting the flat regions and the larger plaice retiring to deeper waters, especially in late summer.) These grounds also supply the adjoining regions with progeny, above all the West Pomeranian coasts. It is therefore necessary to prevent this progeny from being captured too soon and in too great quantities. Moreover the small plaice fetch a comparatively low price and in general by their large quantities depress the market price. It is certainly a more rational mode of procedure to catch smaller quantities, but on the other hand larger fish; another advantage is thereby also secured, namely that the smaller fish if protected grow up in 1—2 years and attain a good market size.

Protective measures.

The critical state of the plaice fishery in the Belt Sea and the Baltic was recognized at the meeting in Copenhagen on November 14th 1927 by all the members of the Transition Area and Baltic Area Committees, and it was decided to recommend the measures mentioned in the Introduction by K. A. Andersson and A. C. Johansen for the protection of the plaice fishery to the International Council.

Germany will also warmly recommend their enforcement:

It is absolutely necessary to make an attempt to restore to some extent the completely ruined plaice fishery in the Western Baltic, and to this aim the following should contribute:

1) The protection of the young fish,
   a) of the youngest stages by prohibiting trawling and Danish seine fishery within the territorial waters where the depth is less than 20 metres.
   b) of the somewhat older young fish by raising the size limit above its former figure. A raising of the size limit is here urgently required, from 21 and 22 cm. to 24 cm., since the biological conditions have changed, the rate of growth has increased materially, and fish 24 cm. in length are now younger than fish of 21 cm. were formerly. There can be no question of serious damage being inflicted on the fishermen, for fish under 24 cm. in length are here only to a slight degree the object of the fishery.
2) The protection of spawning fish by instituting a close season during and immediately after the spawning period. There is no need to point out how important it is that the spawning fish should not be destroyed when actually engaged in the process of reproduction, but it is also quite irrational to capture the fish immediately after the spawning period. They are then close together in large numbers and are easily caught

but are of inferior quality and consequently only fetch low prices. If fishermen would wait a few weeks, the fish would be in a much better condition and their capture would prove more remunerative.

In the Baltic proper the institution of the proposed measures of protection should above all prevent the stock of fish being depleted here to the same extent as has occurred in the western area. Especially the destructive winter fishery must be prevented by instituting a close season as soon as possible.

The protection of the young fish is however also of importance for the promotion of the fishery. The size limit of 18 cm. enforced hitherto is too low. The rate of growth has also here increased materially, although not so much as in the western part. From a biological point of view it would be perfectly justified to raise the size limit to 22 cm. It must however be emphasized that this will in many cases mean a great reduction in profit for the fishermen, although we consider them capable of sustaining the loss, especially as they are now often compelled to waste 1—2 days in harbour, when their catches have been heavy, because the dealers do not take the fish off their hands any earlier. We are convinced that the whole fishing trade will function more smoothly and with more uniform prices if the bulk of inferior fish are kept away from the market.

A prohibition of trawling in the flat coastal regions would also in the Baltic proper be an important measure in the interest of the young fish stock but at present economic reasons stand in the way of its being strictly enforced along all coasts, especially in the area of the Swinemünde Bay, so that Nordpeerd on Rügen is suggested by Germany as the limit of the coastal region to be protected.

All the protective measures have up to now been designed for the benefit of the plaice fishery alone. Germany must however emphasize that their partial extension so as to benefit flounders also is desired. This fish is not of the great importance to Denmark and Sweden that it is to Germany and Poland. For the coasts of Pomerania the flounder is the backbone of the fishery. In Germany efforts are being made to bring about the extension of the close season for plaice so as to include flounders also, in order above all to stop the Bornholm fishery which is so ruinous for this fish also.

III. SPECIAL PAPERS CONCERNING THE PROPOSALS FOR PROTECTION OF THE SALMON AND SEA-TROUT IN THE BALTIC

1. The Salmon in the Baltic area of Sweden.

By

Gunnar Alm.

a. The occurrence of the salmon and the yield of the salmon fishery in the Baltic area of Sweden.

Nowadays the salmon is to be found in all the larger and in some of the smaller rivers in the northern and middle parts of Sweden and also in some few waters in the southern parts of this country. The most important Baltic salmon rivers are Torne, Kalix, Lule, Ume, Ångerman, Fax, Indals, Ljunga, Ljusna, Dalecarlia and Mörrum rivers. In all of these rivers, as well as in all other waters, where the salmon ascends, there is generally a very intense fishery for salmon. This fishery is carried on with seines, gill nets and landing nets, as well as with different kinds of traps.

In the Baltic the salmon is the object of fishery from the Swedish side, partly along and near those coasts where the most important salmon-rivers join the sea and consequently above all in the counties of the northern part of Sweden (Norrland) partly off the coasts of Scania and Blekinge and round the island Gotland, besides which Swedish fishermen, especially from the province of Blekinge, take part in the often very good salmon fishery round Bornholm, as well as at other places in the open sea in the southern part of the Baltic. The coast fishery for salmon in Norrland is carried on principally with gill nets and big traps, along the southern coasts with anchored gill nets, partly with seines and around Gotland and Bornholm and in the open sea chiefly with floating hooks and driftnets.

The yield of the salmon fishery in the Baltic rivers and in the Baltic itself has during the latter years, for which reliable statistics are to be had, varied between 150,000 and 606,000 kg. Regarding these latter accounts as well as earlier accounts concerning salmon catches see Alm 1928 (Der Lachs und die Lachszucht in verschiedenen Ländern, table 4). From these accounts it will appear that the salmon fishery in Sweden has always been of great importance and has also shown great fluctuations. Consequently periods or years with good catches have alternated with those with bad catches.

b. The biology of the Salmon in the Baltic rivers of Sweden.

The ascent of the salmon in the Baltic rivers of Sweden takes place during the summer and generally during a shorter and more limited period the more northward a river is situated. Consequently, the migration up the river starts as early as March or April in the Mörrum river and lasts there till October. Ascending salmons are also

to be found in this river during other months. In the Dalecarlia and in the Ljusna rivers the ascent commences in May or June and is generally finished in the beginning of September. In the Lule and Torne rivers the salmon does not begin to migrate until the end of June. At the beginning of the ascent larger salmons are generally coming, but towards the end smaller individuals are ascending, most of which are males. The ascent is, as O. Nordqvist has shown, in a certain relation to the height of water in the rivers.

The spawning takes place in the northern rivers during the end of September — beginning of October, in the Mörrum river during the latter part of October and during the month of November. When the spawning is finished a great part of the salmons return to the sea, whereas several salmons, at least in some rivers stay in the river during the winter not returning to the sea until the following spring.

The seawards migration of the young salmons generally takes place during spring and early summer at an age of 1—4 years. In the northern Norrland their age is principally 3 and 4 years (Rosén) in the Mörrum river chiefly 2 years (Alm). The percentage of the different age-groups will appear from table 1.

Table 1. The age of the salmons at their first migration to the sea (%).

Rivers	No. of ind.	The age at the first descent				
		1 year %	2 years %	3 years %	4 years %	5 years %
Torne	21	..	4.8	76.2	19.0	..
Kalix	30	..	3.3	53.3	43.3	..
Lule	177	..	9.0	49.7	39.0	2.3
Pite	57	..	5.3	52.6	42.1	..
Ume	146	..	54.1	43.2	2.7	..
Mörrum, 1916—18[1])	81	1.5	76.5	22.0	..	..
— 1919	73	..	79.5	20.5	..	..
— 1920	169	3.9	90.0	6.1	..	..
— 1921	124	12.1	77.4	10.5	..	..
— 1922	337	10.7	84.3	5.0	..	..
— 1923	210	5.7	84.3	10.0	..	..

[1] Years when the catches are made.

The size of the different age groups at the descent is as follows:

	1 year	2 years	3 years	4 years
Lule river	—	14.5 cm.	16 cm.	16.5 cm.
Ume river	—	12 —	15.5 —	(15.5) —
Mörrum river	8.5 cm. 9 gr.	11.5 — 18 gr.	14.5 — 30 gr.	—

After the descent the salmon stays for 1.5—3 years, exceptionally a shorter or longer time, in the sea before it ascends for the spawning and it returns according to Scotch, American and recent Swedish marking experiments nearly without exception to its native river.

Table 2. Number of years in the sea before the first ascent to the spawning (%).

River	No. of ind.	No. of years in the sea			
		1,5	2—2,5	3	4
Torne	21	..	42.9	52.4	4.7
Kalix	30	16.6	53.3	26.6	3.3
Lule	177	11.9	35.6	40.1	12.4
Pite	58	3.4	29.3	58.6	8.6
Ume	147	2.1	19.7	77.5	0.7
Mörrum, 1916—18[1])	81	4.9[2])	14.8	76.6	3.7
— 1919	73	17.8	52.1	17.8	12.3
— 1920	169	..	39.7	59.7	0.6
— 1921	124	..	9.7	86.3	4.0
— 1922	337	..	7.4	90.5	2.1
— 1923	210	6.7	10.5	79.0	3.2

[1]) Years when the catches are made.

[2]) The figures concerning the small salmons are in reality somewhat higher, as some small salmons have been excluded by mistake at the collection.

Table 2 shows the relative percentage of salmons with different long sea life before the ascent. From this table it will appear that the age at the ascent is very varying in different rivers, as well as during different years in the same river. On the whole, the salmon does not seem to become very old as, according to the above, the ordinary age of the salmon at the catch is 4—6 years. Very seldom the salmon seems to grow older than 8—9 years.

The size of the ascending salmon is as follows:—

Years in the sea		
1.5	2—2.5	3—4
45 —65 cm. 0.7— 3 kg.	73 —85 cm. 4.5— 7.5 kg.	90—120 cm. 8— 15 (20) kg.

Only very few males (3—4 per cent.) seem to spawn more than once.

The average size of the salmon caught in the rivers is, of course, dependent of the age at the ascent. As the salmon in the Swedish rivers generally ascends after 2—2.5 and more often after 3 years in the sea the average size also is high. Thus, the average weight during 1923 was as follows:—

Torne	river	10 kg.
Lule	—	10.8 -
Ume	—	9.3 -
Ångerman	—	10.5 -
Indal	—	9.5 -
Ljunga	—	9.3 -
Mörrum	—	8.3 -

The average size, however, varies during different years, as it is dependent on the relative percentage of the different age groups. This again is connected partly with the strength of the different year classes, partly with the temperature of the sea water, so far as a high temperature seems to accelerate the maturity and consequently also the ascent, as JACOBSEN, JOHANSEN and the author have shown.

Irrespective of such changes in the age of the stock, the different percentages of salmon with a certain number of years in the river and in the sea seem to be comparatively constant in different rivers. In one river consequently, the salmon is large *i.e.* the percentage of salmon with a long sea life is high, in another river again the salmon is smaller in consequence of a higher percent of younger salmon (see table 2).

c. The appearance of the salmon in the Baltic.

1) The occurrence of the small salmon.

After the descent, consequently at a size of 11—16 cm., the salmons quite disappear. This is, as DAHL holds forth, probably due to a pelagic life, but after a year in the sea when they have attained a length of 40—50 cm. and a weight of 0.45—1 kg. they appear at the shallow and shelving coast of Scania during spring and there become the object of fishing. This fishery takes place chiefly during April and May and to some extent also during March and June, whereas salmons are very seldom caught here during other seasons. From an examination that O. NORDQVIST made of 168 salmons caught in this district it appeared that out of the said number 120 or 71 per cent. were less than 50 cm. in length and with a weight of 1 kg. at the highest. It was also found that none of these small salmons were less than 40 cm. corresponding to a weight of 0.45 kg. According to informations given by the fishermen salmons with a weight of less than 0.5 kg. are very seldom caught and never those with a weight of less than 0.4 kg. This must be due to the fact that there are no smaller salmons here, because fishery for other kinds of fish is going on here with different small meshed nets in which such smaller salmons would be caught if there were any. The average size of the small salmons was about 47 cm., most of them varying between 43 and 53 cm. The larger salmon caught at the same time had a length of 78—88 cm. and a weight of 4.5—5.5 kg. Obviously these two size groups are corresponding to those salmons which are caught in the rivers after 1.5 and 2—2.5 and partly also after 3 years sea life. Consequently, the salmon seems to make for the coast of Scania during the latter part of its first year in the sea and partly also during the end of the second year there.

In the salmon fishery round Bornholm, in which fishery also Swedish fishermen chiefly from Blekinge take part, small salmons as well as plenty of large salmons with a sea life of 2 and 3 years are caught. The salmon caught at Gotland consists according to HESSLE entirely of larger individuals with a sea life of 2 and 3 years.

Regarding the salmon fishery in the southern part of the Baltic the fact may be pointed out that the catches here consist of small as well as of large salmons and consequently of all age groups.

The salmon caught in the northern part of the Baltic, on the other hand, consists as a rule of larger individuals only, *i.e.* salmons ascending the rivers there, which to a very little degree consist of individuals with a sea life of only 1.5 year. These smaller salmons are generally caught during the latter part of the fishing season and they have according to the above already attained a size of 45—65 cm. and 0.7—3 kg. Some years, however, and especially in the northern part of Norrland such small salmons and also considerably smaller individuals are caught in greater numbers than usual. According to Olofsson small salmons have appeared in greater numbers in the northern part of Norrland during the years 1877, 1898, 1910, 1916, 1919 and above all 1925. One must, however, remember that "small salmons" in this meaning includes really small salmons with a weight of less than 1 kg., as well as individuals with a weight of 1.5—2.5 kg. and with a sea life of 1.5 year. During 1925, for instance, the number of small salmons in a catch in the archipelago outside Piteå made 67 per cent., at Hertsö in the mouth of the Lule river 57.6 per cent., and at Edefors in Lule river 46.5 per cent. of the total catch. Consequently, there was during this year a great amount of young salmons in these areas in the archipelagos as well as in the rivers. Especially the occurrence of small individuals with a weight of 0.4, 0.5, 0.55, 0.6, 0.7 kg. and so on caught during the spring and early summer indicates the fact that these salmons had been only 1 year in the sea, and consequently belonged to the same type as the small salmons which are caught every year at the coasts of the southern part of the Baltic.

As a summary of the above the following may be said. The smallest salmon with a length of 40—50 cm. and a weight of 0.45—0.9 kg. and with a sea life of near or about 1 year is always to be found at the shallow and shelving sandy coasts of the southern part of the Baltic along the continent as well as round the islands, especially Bornholm. In the northern Baltic, on the other hand, only salmons of such a small size are exceptionally caught. But during their second year in the sea, though later in the summer, small salmons are caught in archipelagos inside which salmon rivers join the sea as well as in these rivers. These catches are, however, of little importance because only a small number of salmons ascend the rivers after having stayed only 1.5 year in the sea.

Larger salmons of the size groups 70—85 and 90—100 cm. and above are caught partly in the southern part of the Baltic on the Swedish coast, above all outside Blekinge, partly round Gotland and partly in the archipelagos, especially in Norrland where the salmon rivers fall into the sea.

2) The migrations of the salmon.

Especially obvious is the rich occurrence of small salmon in the southern part of the Baltic. This indicates that these small salmons prefer coastal waters of the type described above. Considering the fact that such small salmons as a rule do not appear along the coasts of Norrland it is probable that the small salmon appearing at the coast of Scania and round Bornholm originate from the rivers of Norrland. The salmons which migrate from the rivers falling into the northern part of the Baltic consequently seem to go down to the southern part of the Baltic during their first year in the sea. Several circumstances prove that this supposition is right and that the salmon makes long

migrations. Thus salmons having fish hooks of German origin attached have been caught in the northern part of the Baltic, and on the other hand salmons with hooks of Finnish and North-Swedish origin have been found in the southern part of the Baltic. Early marking experiments on larger salmons were already made in order to investigate the migrations. Though no great results have been gained by these experiments, they have, however, shown the same state of things as the hook finds.

In 1923 Hessle carried out an investigation of the age of salmons caught in the vicinity of Gotland. He found, that 45.4 per cent. of these salmons had lived for 3 and not less than 12.1 per cent. for 4 years in the river before the migration to the sea. As salmons with a youth period of 3 years in the river chiefly, and such with a youth period of 4 years in the river exclusively, are to be found in the rivers in the northern Sweden — and probably also in those of Finland — it is quite obvious, that a great part of the salmons caught in the middle part of the Baltic round Gotland must originate from rivers falling into the northern part of the Baltic. The same was the case with 43 salmons caught in the western part of the archipelago of Blekinge during the spring of 1925. An investigation showed, however, that not less than 19 individuals or 44.2 per cent. of these salmons had lived for 3 years in the river before the descent to the sea which, consequently, indicates a northern origin of these salmons.

These investigations make it probable, as Hessle already has pointed out, that it is the salmons originating from the northern rivers which are caught on the coasts of Blekinge and Gotland on their way back to their native rivers after having lived the first years in the southern part of the Baltic. That this is the case, or in other words, that they really are salmons from the said rivers which are caught in the southern part of the Baltic during their first as well as during their later years in the sea, has now, however, been positively proved by the following marking experiments.

During the years 1924—1926 6335 young salmons were marked which had been reared in ponds at a fish hatchery in the northern part of Sweden. The marks consisted of a silver thread with a numberplate at its outer end. These marks were fixed to the base of the front part of the dorsal fin. The salmons were 2—4 years old with a size of 8—23 cm. The bulk of them were silvery and ready for the descent to the sea. The marking was always made in the first days of June and the young salmons marked were liberated partly in the Indal river about 90 km. from the mouth and partly in the Ångerman river about 60 km. from the mouth.

Of these young salmons thus marked about thirty individuals were caught before they had had time to migrate to the sea. Besides these, however, 12 individuals have been recaptured (table 3) 3 of which in the two rivers where the marked salmons had been liberated after having stayed 1.5 year or nearly 2 summers in the sea. The other 9 individuals, on the other hand, have all been recaptured in the southern part of the Baltic. Four individuals of these latter had lived 1 year in the sea, two of them were caught near Scania, one outside Falster and one on the coast of Pomerania. Another salmon which had lived 1.5 year in the sea had extended its ramble as far as the north-eastern part of Zealand. Three individuals were recaptured after 2 years in the sea. One of these were caught near Bornholm and the two others outside the Pomeranian coast.

Table 3. The results (to and including the year 1927) of marking with young salmons in Sweden.

Marked			Recaptured				
Locality	Date	No.	Locality	Date	Size cm	Weight kg	Number of years in the sea
Indal river	4. VI. 1926	S 4267	Scania, Skillinge (Simrishamn)	16. III. 1927	44	0.5	1
— —	5. VI. —	S 5817	Falster, Marienlyst	26. III. —	40	0.41	1
— —	4. VI. —	S 5415	Pomerania, Rügenwaldermünde	15. III. —	45	0.55	1
Ångerman —	10. VI. —	S 3550	Scania, Böste, S. Åby	28. III. —	?	0.5	1
— —	8. VI. —	S 3077	Zealand, Hornbaekbugten	10. VII. —	?	ca. 0.85	1.5
Indal —	5. VI. 1925	S 1662	Poland, Hela	14. IV. —	80	4.6	2
— —	5. VI. —	S 1128	Poland, Danziger Bucht	26. IV. —	83	6.4	2
— —	5. VI. —	S 1306	Indal river Stadsforsen[1])	19. IX. 1926	57.5	1.5	1.7
Ångerman —	6. VI. —	S 2145	Bornholm, 6 km SW of Dueodde	11. III. 1927	?	4.0	2
— —	6. VI. —	S 2152	Ångerman river, Forsmo	25. VII.1926	58	1.8	1.6
Indal —	3. VI. 1924	332	East Prussia, Neukuhren	22. III. 1927	105	9.5	3

[1]) At the same time a marked salmon of the same weight was caught which had lost the numberplate. Only the silverthread was left.

Finally one salmon was caught at Neukuhren in East Prussia which had lived 3 years in the sea. Through the results of these marking experiments it has thus been fully proved, that the salmon finds its way down to the southern parts of the Baltic from the rivers falling into the northern part of the Baltic.

Without a closer knowledge of the connection between the salmon fishery in the southern part of the Baltic and in the rivers the supposition may be expressed, that the salmons from the southern Baltic rivers also migrate up to the northern part of the Baltic and there become the object of fishing by Swedish and Finnish fishermen. However, apart from the fact, that small salmon only sporadically is to be found in the northern part of the Baltic during their first year in the sea, a marking experiment made by Henking in Persante on small young salmons showed that all these were recaptured more or less near the place where they had been liberated. These small salmons, it is true, had been caught rather shortly after they had been marked and consequently had not been able to make any long migrations. It may, however, be pointed out that no marked small salmons have been found in the vicinity of the mouths of those Swedish

rivers, where marking experiments have been carried out. This fact makes it probable that these latter young salmons have at once started on their southward journey, whereas young salmons which had been marked in Persante had remained in the vicinity after their descent to the sea.

A positive evidence of this being the case also during the first year in the sea is given by a salmon which had been marked October 23rd, 1914, in Persante and which was caught at Gr. Horst in Pomerania November 2nd, 1915. This individual, which had a size of 12.6 cm. when it was marked, had attained a length of 36.8 cm. when it was recaptured. It had probably descended to the sea during the spring of 1915 and then remained in the southern part of the Baltic during its first year in the sea.

Consequently, one is entitled to say that the small salmons from the northern Baltic rivers migrate down to the southern part of the Baltic, whereas there is no evidence of salmons originating from the German and Polish rivers migrating to the northern part of the Baltic.

3) The connection between the salmon fishery in the southern part of the Baltic and in the northern Baltic rivers.

The facts mentioned above indicate that salmon originating from Swedish — probably also Finnish — rivers is the object of an intense fishery during its first year in the sea in those countries which surround the southern part of the Baltic *i. e.* Denmark, Germany and Poland and possibly also Latvia. The coast fishery carried on by the fishermen from these countries is rather important (see the German and Danish reports and also Alm 1928). The catch at Bornholm varies between about 17,000 and 117,000 kg. and on the German coast between about 5,000 and 200,000 kg. On the Polish coast not less than 74,000 kg. were caught during 1924, and 66,000 kg. were caught on the Latvian coast during the same year. From these figures it will appear, that there are quite large quantities of salmon which are caught in the southern part of the Baltic which quantities according to the above to a great extent originate from salmon rivers falling into the northern part of the Baltic. Especially is this the case regarding Denmark, which country has no salmon river of importance falling into the Baltic, and even the rivers falling into the southern parts of the Baltic have according to statements in the literature no great stocks of salmon. Thus according to Trybom, the Oder had already lost nearly its whole stock of salmon in about 1840 and the catch of large salmon in the lower parts of the Vistula did not amount to more than an annual average of about 6554 kg. during the years 1848—1861. According to Henking the salmon catch in three districts here during the years 1896—1905 amounted to between 1189 and 3292 kg. and in the German river Persante to between about 250 and 2080 kg. during the years 1887—1911. Consequently it is obvious, that these rivers can not be the origin of any greater quantities of salmon in the southern Baltic. Whether the rivers falling into the middle part of the Baltic have any rich stocks of salmon is at present unknown. It is, however, stated that the river fishery for salmon in Latvia is giving an annual yield of about 80,000 kg. It is, however, obvious, that the northern Baltic rivers have a total stock of salmon, which is much larger than that of the rivers falling into the southern or middle parts of the Baltic.

Consequently, if the salmon fishery in the southern part of the Baltic, according to our supposition, to a great extent is based on salmon originating from the northern rivers, we may be able to show a connection between the fishery in the southern part of the Baltic and in the said rivers. This is also the case. The salmon fishery in the northern rivers in Sweden and at Gotland and Blekinge shows very good catches during the last decade of the 19th century and during the years 1919—1922, whereas the salmon fishery has been poor during the beginning of this century as well as during the last years. The same fluctuations appear, however, not only in the salmon fishery around Gotland, but also in the salmon fishery which is carried on by fishermen from Blekinge in southern Sweden and from Denmark and Germany (See diagrams, fig. 2 and 3, Alm 1928). The said rich periods of the salmon fishery in the sea correspond to rich periods of the fishery in the rivers in the northern Sweden and in Ule river in Finland. If the catches from the Bleking, Danish and German fisheries are summed up, which has been made in table 4 and graphically shown in fig. 1, the said correspondence will more clearly appear. One can see how well the curve of the salmon fishery in the southern part of the Baltic is following the curve of the fishery in some of the rivers in the northern Sweden. It may, however, be observed that the latter curve is displaced a year forth so that maxima and minima of the river fishery take place a year later than of the fishery in the sea. This is, however, only a further evidence of the connection in question, as it is obvious, that a rich year class from a river in northern Sweden because of its migrating down to the southern part of the Baltic will be the object of fishery already during its first and at the beginning of its second year in the sea, whereas the river fishery for the same year class does not start until the latter part of the second year in the sea when the salmon starts its migration into the rivers.

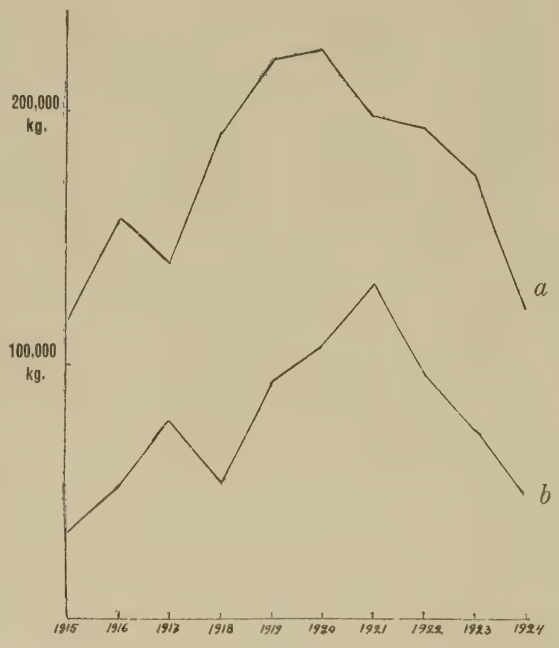

Fig. 1. Comparison between the landings of salmon in the southern part of the Baltic, *a*, (Blekinge+Bornholm+Germany) and the landings of salmon in the most northern salmon rivers of Sweden, *b*, (Torne+Kalix+Lule rivers).

It may also be observed, that the curve of the catches in the Mörrum river, which certainly is one of the richest salmon rivers of the southern Baltic area, does not show these fluctuations, or in any case not to such a degree as the curve of the catches in the northern rivers. As also the salmon fishery outside Blekinge, which in any case must be partly based on Mörrum salmon, shows the same fluctuations as the fishery in the rivers in the northern Sweden (and in Finland) we must look upon this fact as a new

Table 4. Quantities of salmon (in 1,000 of kg.) landed in the southern part of the Baltic and in the northernmost rivers of Sweden and in Ule river in Finland.

Years	Blekinge Denmark Germany	Ule and Ångerman rivers	Years	Blekinge Denmark Germany	Torne Kalix and Lule rivers
1895.....	290	66	1909.....	50	..
96.....	291	71	1910.....	97	..
97.....	332	65	11.....	80	..
98.....	266	69	12.....	92	..
99.....	191	35	13.....	..	..
1900.....	221	37	14.....	128	..
01.....	182	25	1915.....	118	36
02.....	..	14	16.....	158	53
03.....	87	14	17.....	141	79
04.....	93	17	18.....	191	56
1905.....	63	20	19.....	220	92
06.....	32	..	1920.....	225	108
07.....	39	..	21.....	198	131
08.....	52	..	22.....	194	96
			23.....	174	75
			24.....	119	49

evidence of the great importance of these rivers for the stock of salmon in the southern part of the Baltic.

The above may be summarized as follows: The greater part of the stock of salmon of the Baltic both from the northern and southern rivers finds its way to the southern part of the Baltic during its first year in the sea. As the northern rivers are of a much greater importance than the southern the bulk of the salmon appearing in the southern part of the Baltic consists of salmons originating from the northern rivers. Consequently a great part, in certain areas the greatest part, of the salmon fishery, which is carried on by Swedish, Danish, German, Polish and possibly also Latvian fishermen is based on salmon from the northern rivers.

d. The fluctuations of the salmon fishery and their causes.

Because of the connection between the salmon fishery in the southern Baltic and in the northern rivers and the great importance of these rivers for the Baltic fishery which has been stated in the foregoing chapter it is obviously of great interest to study the fluctuations of the salmon fishery and their causes and also the factors which promote or cramp the stock of salmon in these rivers and also the stock of salmon in the sea.

1) The natural fluctuations of the salmon fishery.

It has been pointed out above that the salmon fishery in the northern Baltic rivers, as well as in the southern part of the Baltic, showed periods of very rich years during the last decade of the 19th century, except during the last years of that decade and during 1919—1922. Other periods of good years appear in the beginning of the 19th century, about 1870 and at the middle and end of the eighties. The latter period in reality being a beginning of the good period in the nineties. Periods and years with bad salmon fisheries appeared, according to older documents, during the beginning of the 17th century in Torne river and according to Gisler and Hülphers in several rivers between 1740 and 1750, about 1880, during the last years and above all about and during the beginning of this century.

Though neither the connection mentioned above nor the dependance of one another of the different salmon fisheries was known, one could not escape at an early period to notice these great fluctuations and also the fact that they were rather similar throughout large areas. This was especially the case regarding the great decrease of the salmon fishery about 1900, which decrease, as we have seen, was very prominent in the northern salmon rivers in Sweden and Finland, as well as in the salmon fishery in the Baltic. Concerning Sweden and Finland one ascribed this disastrous decrease partly to the dambuildings and the pollution of the rivers, partly and above all to the more and more intense timberfloating. Some voices, however, were heard declaring that this decrease had other causes. Thus above all Henking pointed out the simultaneousness in the decrease and also the probability of its dependance of several factors especially unfavourable spawning conditions.

This question was, however, not under discussion during the following years. Through the investigations regarding the influence of the timber floating on the fishery in the rivers which Levander and Järvi in Finland and I myself in Sweden carried out it appeared, however, that the floating could not be the most important cause of the great decrease about 1900, even if it evidently damaged the stock of salmon and the salmon fishery. I therefore took up the question concerning the causes of this decrease for critical examination in connection with investigations of the biology of the salmon in the Mörrum river. The results of these investigations were set forth in a paper regarding the fluctuations of the salmon fishery which was published in 1924. I think I have been able in this paper to show that the peculiar climatic conditions concerning rainfall and height of water which prevailed in the northern part of Sweden during several years of the nineties have been the cause of the decrease about 1900. This conclusion is based on the following facts. The decrease can hardly have been caused by other factors than such which have influenced simultaneously throughout large areas, and which have brought on a reduced production of salmon fry. The salmon is chiefly 4—6 years old at the ascent in the rivers of the northern Sweden. Consequently, to be able to explain the decrease about 1900 one must go back to the years during the middle of the nineties and then make the supposition that the production of fry have been remarkably bad during the said years. The salmon fishery was very good so it can not be an insufficient amount of spawning salmons which have caused the bad supply of fry. Consequently the cause

must be sought for in some factor which have an unfavourable influence on the eggs and which also appear simultaneously throughout large areas. Such a factor of fundamental importance is certainly the height of the water.

In the rivers in the northern part of Sweden the water is highest during early summer but lowest during the latter part of the winter. Consequently, the water is generally sinking from the autumn to the spring, and the more the higher the water is in the autumn or the stronger the rainfalls have been during the summer. As the eggs of the salmon rest on the bottom of the rivers generally at a depth of $^1/_2$—2 m., a stronger lowering of the height of the water during the winter must cause the eggs being left high and dry or being killed through freezing or through pressing by the ice.

It was found that several of the years during the nineties were remarkable for very strong lowerings of the height of the water. As an example may be mentioned the fluctuations of the water level in the Indal river during the winters 1892—93 and 1893—94, which is one of the few rivers from which notices about the height of the water are to be had. Whereas the normal lowering of the water level in this river during the winter is 129 cm. it was during the said winters 235 and 249 respectively. Similar peculiar conditions are also to be found in other rivers.

As a strong lowering of the height of the water during the winter is in connection with large rainfalls during the summer it is of a certain interest to state that the rainfall in the northern part of Sweden was much heavier during the nineties than during other periods. At 11 meteorological stations in northern Sweden the total number of years with a rainfall above the average and the total number of those with a rainfall under the average for different 5-year-periods is as follows:—

	above	under
1886—1890	13	31
1891—1895	13	25
1896—1900	27	17
1901—1905	11	31
1906—1910	17	22
1911—1915	15	29
1916—1920	20	26

From Finland there are also figures known which show that the rainfall was exceptionally strong during the nineties.

Consequently, the great decrease of the salmon fishery about 1900 was certainly caused by unfavourable conditions for the spawning. I already then explained the great decrease of the salmon fishery in the southern part of the Baltic as a sign of the dependance of this fishery of the stocks of salmons in the northern rivers as no corresponding decrease could be traced in the rivers falling into the southern part of the Baltic, where also other conditions concerning height of the water and rainfall than in the northern part of Sweden are prevailing.

Above is mentioned that the salmon fishery has been poor during the last years and also during the years about 1880. Without entering into details regarding the conditions concerning the height of the water I wish, however, to point out that considerable

aberrations have been found also during the years 1918—1919 and 1921—1922. The rainfall has also, as shown by the figures above, been above the average during several years about 1920. Though I have not yet had the opportunity to publish any detailed investigations regarding this question, I wish to point out the probable connection between the comparatively poor salmon catches during the last years and the said unfavourable hydrographic conditions.

The bad years about 1880 are probably also to a certain extent caused by the peculiar conditions concerning rainfall (and height of the water) during the first part of the seventies, the rainfall, according to accessible information being considerably stronger than usual during the years 1872 and 1873.

Consequently it is probable that the great decreases of the salmon fishery in the northern Baltic rivers, as well as of the fishery in the southern part of the Baltic may be declared through unfavourable conditions prevailing throughout large areas of the northern part of Sweden and Finland, which by decimating the eggs of the salmon cause a poor supply of fry. One must, however, also be entitled to suppose that the richer salmon periods are caused by particularly favourable conditions for the production of fry some years earlier.

2) The decrease of the salmon fishery through the activity of man.

Though, as we have seen, the great fluctuations of the salmon fishing obviously are caused by climatic (hydrographic) factors, there are nevertheless fluctuations which are dependent of other causes. But these fluctuations manifest themselves by a more or less strong decrease of the salmon fishery in different rivers and areas of the sea.

Thus, the salmon has nearly disappeared from rivers where earlier there was a good salmon fishery. This is the case in Gävle river, Mälaren-Norrström, Motala, Em and Helge rivers. In Ljunga and Dalecarlia rivers, which both earlier were good salmon rivers, the salmon fishery has not recovered after the great decrease about 1900 and consequently not shown the same increase about 1920 as in other rivers. Finally it appears from the unfortunately too sporadic statistical notices from earlier years that the salmon fishery in several rivers has been better than nowadays. In table 5 some of the best and poorest years concerning the salmon catches in different rivers during earlier and later good salmon periods have been compared.

From this table it will appear first of all the great decrease in the Ljunga and Dalecarlia rivers. The decrease is also rather strong in the Torne river and regarding Lule river, Ume river and Ljusna river the good years during the eighties were considerably better than the corresponding years during the latter good period 1918—1923, and regarding the Ångerman river several years during the nineties were better than the best years during the last period. Also in the case of the Indal river the figures indicate such a decrease. The poorest years show also the same result, as these years all are better during earlier periods than during later periods. It is consequently obvious, that the salmon fishery in these rivers has been better during earlier good periods than during later, *i.e.* a deterioration has taken place.

Regarding the Mörrum river it is more difficult to show a decrease of the catches

Table 5. Comparison between the best and the poorest years conce

	Periods	Torne river	Kalix river	Lule river	Ume river	Ångerman river
Best years	Before 1899	144,500	82,980	100,550	69,700	37,740
		137,340	42,410	84,200	47,800	33,770
		117,060	27,250	59,950	36,700	33,170
		100,200	19,920	33,630	34,400	27,970
		79,440	15,840	..	31,600	27,020
	Average	115,696	37,680	69,583	44,060	31,934
	After 1910	55,330	25,190	57,790	16,660	23,300
		43,580	25,100	57,240	16,350	21,570
		41,380	19,380	39,340	13,200	18,620
		31,990	17,670	38,490	12,690	17,370
		31,670	15,870	35,360	11,800	15,890
	Average	40,790	20,642	41,444	14,140	19,350
Poorest years	Before 1899	25,620	15,350	..	18,870	9,400
		32,000	15,840	..	19,100	20,010
		33,910	19,920	..	22,260	20,020
	Average	30,510	17,037	..	20,077	16,477
	After 1910	15,530	4,880	..	6,500	6,760
		16,490	6,700	..	7,650	10,850
		23,570	8,380	..	7,700	11,800
	Average	18,530	6,653	..	7,283	9,803

in the river except during some of the last years. The statistics of the salmon fishery at Elleholm at the mouth of the river (published by me 1924) indicate, however, a slight decrease.

Regarding the coast fishery a marked decrease can be shown in the case of Västernorrlands län and Blekinge, whereas the rest of the Swedish coast fishery for salmon has given about the same or only slightly poorer yield during latter than during former good periods. The coast fishery of Denmark and Germany, on the other hand, like that of Blekinge show better catches during earlier than during latter good periods, as will be seen from table 4 and fig. 1.

The causes of this decrease of the salmon fishery are in some cases not difficult to find out. Concerning those rivers where the salmon quite or partly has disappeared dam-buildings and pollution doubtless play the greatest part. There are as a matter of fact several dam-buildings in the Ljunga, Gävle and Dalecarlia rivers, in the most of the tributaries of the Mälar, in Motala, Em and Helge rivers, whereas such buildings only rarely or not at all are to be found in the rest of the salmon rivers. Exceptions from this rule are the Ljusna and Mörrum rivers, but these two rivers are remarkable for the very good spawning places in their lower parts, why the dam-buildings further upstream

atches during earlier and later periods of good salmon fishery.

	Ljusna river	Dalecarlia river	Västerbottens län	Västernorrlands län	Gotlands län	Blekinge län	Malmöhus län
	61,380	70,800	31,800	31,990	48,400	92,000	12,600
	38,500	56,200	31,100	31,310	28,600	64,000	11,350
	37,290	54,700	31,000	30,320	25,000	63,600	11,120
	28,550	54,500	29,300	29,350	24,050	48,600	7,850
	22,260	46,700	29,000	25,430	21,000	48,000	7,140
	37,596	56,580	30,440	29,680	30,210	63,240	10,012
	21,570	32,000	43,640	21,720	34,790	77,860	14,140
	21,570	12,240	34,130	16,920	27,380	73,610	13,090
	21,150	11,800	30,360	16,170	26,820	46,600	9,300
	15,840	8,880	24,320	15,460	15,250	40,030	7,750
	15,320	8,420	20,950	14,670	5,890	39,230	7,660
	19,090	14,668	30,680	16,988	22,026	55,466	10,380
	18,870	19,500	7,400	17,090	2,660	8,050	980
	19,100	22,730	9,100	14,860	3,800	10,500	2,810
	22,260	24,000	9,700	19,380	6,520	18,500	2,820
	20,077	22,077	8,733	17,110	4,327	12,350	2,203
	8,000	1,820	15,980	6,460	1,290	4,680	1,130
	9,530	2,220	15,580	7,470	1,590	4,970	1,230
	10,390	3,610	16,260	6,370	1,730	5,820	3,540
	9,307	2,550	15,940	6,767	1,537	5,157	1,967

here have not had the same unfavourable influence as in other rivers where they are placed so that they block or in any case render the access to the most important spawning places more difficult. In some cases these buildings have also quite destroyed the spawning places.

In the case of the Gävle river, the tributaries of the Mälar and Norrström, Motala river and partly the Em river there are also polluting works which have still further deteriorated the conditions for the comfort and spawning of the salmon.

In the case of the more common but less obvious decrease of the salmon fishery, thus partly in most of the rivers in the northern part of Sweden, which from the point of view of the salmon fishery have always been the best, partly in the southern part of the Baltic the causes are to be found in other directions. One has hereby to take two factors into consideration, the timberfloating and the fishery.

Though real statistical evidences of the unfavourable influence of the floating have not been produced, one is nevertheless in consequence of my investigations entitled to suppose that the floating has an unfavourable influence on the propagation of the salmon. Fungi and bacteria injurious for the eggs easily disperse from bark which has been torn off by the floating and now lie on the bottom in heaps on or above the spawn-

Table 6. Close seasons in more important salmon rivers.

Rivers	Close season	No. of close days pr. week
Torne ..... river	September 1st—the breaking up of the ice ...	0
Kalix ..... —	— 1st— — — — ...	0
Råne ..... —	— 1st— — — — ...	0
Pite ..... —	— 1st— — — — ...	0
Ume ..... — lower	— 1st— — — — ...	1
— ..... — upper	— 15th —December 31st	1
Skellefte ..... —	— 1st —the breaking up of the ice ...	1
Gide a. o. ..... rivers	— 1st—April 30th	1
Ångerman- and Fax .... —	— 1st— — 30th	2
Indal ..... river	— 1st— — 30th	1
Ljunga ..... —	— 15th— — 30th	1
Ljusna ..... — lower	October 1st—May 15th	1
— ..... — upper	— 1st—June 15th	1
Dalecarlia ..... — lower	September 1st—December 31st	0
— ..... — upper	— 1st—May 1st	0
Em ..... —	— 15th—April 15th	0
Mörrum ..... —	— 15th—December 1st	0
Helge ..... —	— 1st—December 31st	0

Table 7. Close seasons outside the mouths of the salmon rivers.

Rivers	Close season
Pite, Lule, Kalix, Råne, Torne	1st September—the breaking up of the ice
Ljunga	1st September –1st May
Indal	15th September—15th June
Dalecarlia	1st September—31st December
Motala	1st October—31st December
Em	16th September—15th April
Mörrum	The whole year

ing places. Especially the fact that the salmon fishery in the Mörrum river, where no floating takes place, does not seem to have decreased in the same degree as in the rivers in the northern part of Sweden makes it probable that the floating has been a contributing cause of the decrease of the salmon fishery in these rivers.

Another cause of the decrease is doubtless to be found in the fishery, especially the fishery in the sea. During the beginning of this century and also later the sea fishery for salmon has developed very much in the Baltic. It is very probable, that the salmon hereby has been the object of a too intense fishery, which has had an unfavourable influence on the stock of salmon, above all through the catching of small salmons.

In order to protect the stock of salmon and to prevent deterioration of the fishery, by-laws have already been issued long ago, which partly regulate the construction of

Table 8. Size limits for salmon (are in most cases in force also concerning sea trout).

Area or river	On the coast	In the rivers
Norbotten[1]) (certain districts), Pite, Råne, Lule and Kalix rivers	29.5 cm. (10 swed. inches)	30 cm.
Ljunga, Indal and Ångerman rivers	..	50 -
Västernorrland[1])	50 cm.	..
Outside the mouth of Em river[2])	35 -	..
Em river	..	35 -
Blekinge[3])	50 -	..
Kristianstads län[3])	50 -	..
Malmöhus län[3]) 1. I.—30. VI.	50 -	..
— 1. VII.—31. XII.	30 -	..

[1]) On the coast of the Gulf of Bothnia.
[2]) - - - - the middle part of the Baltic.
[3]) - - - - the southern - - - —

the gears partly the fishery seasons. Besides this size limits have often been prescribed as a supplement to the regulations regarding the gears. In the tables 6—8 regulations concerning close seasons and size limits for salmon now in force in Sweden have been compiled.

Finally, artificial propagation has been carried on since the last two decades of the 19th century in the larger salmon rivers.

Regarding the details hereof see Alm 1928, table 20.

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2. Remarks concerning the question of a size limit for Salmon and Sea-Trout.

By

H. Henking.

In Germany there was earlier a size limit of 50 cm. for salmon and of 28 cm. for sea-trout. At that time all fishery authorities expressed their opinion on the question which was very eagerly discussed during 1880—84. Even the Kiel Commission was consulted.

These size limits were doubtless correctly chosen, but in practice they were nevertheless impossible to realize. The fishermen capture in their nets in the inshore waters principally the so called "Speitzken" which, no doubt, are young salmon generally with a length of about 44—50 cm. but also "Stromlachse" with a size of about 50 cm., which latter can be recognized, when alive, by their colour, which, however, they lose immediately after death and become silvery. The fishes are seriously damaged in the nets and lose most of their scales. It would be quite useless to liberate them again, as they can be considered as doomed. It was also impossible to make the fishermen give up these valuable fishes, which constitute their principal source of income during the decline of the flatfish catch in the spring, when the coast fishers are at last able to earn something.

Besides, it is hardly possible for the police officials to distinguish between salmon and sea-trout when dead, and a police force can hardly be stationed in all fishing villages. The crossing between salmon and sea trout which has been proved in the hatcheries may also cause doubts, which certainly in court would lead to a *non-liquet.*

In order to avoid the difficulties referred to, a size limit of 35 cm. for salmon and sea-trout was introduced into Germany some years ago. By this size limit the smallest fishes at least are spared.

Judging from the determinations which Deutscher Seefischerei-Verein according to my initiative has made during the years 1907—1918 on several thousands of measured salmons and sea-trouts, 497 individuals out of one thousand below 50 cm. of salmon and sea trout would have been lost for the fishermen in the district of Königsberg. At Mecklenburg—Eckernförde the fishermen would have been

deprived of as many as 571 fish in every thousand, a loss they were hardly in a position to stand. These figures refer to fishes with a length for the most part of 40—50 cm. and principally of 45—50 cm.

In order to go further into the case it is, in my opinion, necessary in the first place to investigate:

1) of how many indubitably proved salmon (*Salmo salar*) the annual catch of the Baltic countries consists,
2) how many percent of the annual catch the indubitably proved sea-trout (*Salmo trutta*) amount to,
3) to what extent is artificial fertilization of salmon and sea-trout carried on,
4) to what extent is artificial crossbreeding between salmon, sea-trout and brown trout or other salmonids carried on.

When these questions have been answered it may be advisable again to try the size limit for the salmonids.

3. Remarks as to the question of a size limit for the Salmon in the Baltic.

By

T. H. Järvi.

According to by-laws now in force it is prohibited in Finland to sell, buy and serve up salmon caught in this country unless it has attained the length of at least 35 cm. Consequently, if, according to the text of the byelaws, it is permitted to catch salmon of smaller sizes for household use, the regulations are nevertheless practically correlative to a statute of a size limit. This will *inter alia* appear from what is stated below. Regarding the question of a future raising of the size limit of the salmon from 35 to 50 cm. there is from a Finnish point of view no reason against but on the contrary all reason for such a step, either it bears upon a regulation only for the country itself or on a treaty between the different Baltic countries. In Finland, fishing for salmon is almost entirely restricted to the lower parts of the rivers, as well as to places in the sea outside their mouths, or in the vicinity of the mouths of the rivers. There are only very few places with a good salmon fishery which do not belong to the said categories. Practice has shown, that at all these places where, consequently, the principal fishing for salmon in Finland is carried on, the catch consists partly of middlesized (60—80 cm.), partly of large (90—100 cm. or more) salmon, and when smaller ones are to be found (during the later part of the summer) they are not below a length of 50 cm. except in some very rare cases. This has, among other things, appeared from the material consisting of about 7000 individuals, which I have collected for my investigations. Consequently no alterations in the salmon fishery in Finland are to be expected, if the size limit of the salmon is raised. We have, however, a positive interest in the case. Typical hooks found in several salmon, the results of Henking's and of the latest Swedish marking experiments make it probable, that there exists a reciprocity and mixing between the stocks of salmon of the northern and those of the southern parts of the Baltic. It is more than probable, that an important part of the salmon hatched in northern rivers and growing up there to the migrating age during the time following are to be found in the southern parts of the Baltic. Even

if the facts stated above are to be proved with more valid evidences and with a larger material, it seems to me to be a general interest common to all Baltic countries, that the salmon stock should not run the risk of a too early decimation in the southern Baltic through a too intense fishing for small salmon of a weight of only 0.5—1 kg. These small salmon are in a stage where they after a comparatively long period of youth have just attained the years, when the growth is best. Therefore they ought to be spared at least in some degree. If caught at a greater age the same individuals would contribute much more to the size and value of the catch. As Finland has already made a sacrifice of capital and care for the maintenance and increase of the salmon stock and among other things imposed certain obligations upon industrial establishments for the said purposes and also has the intention to continue these efforts I do not hesitate to support Dr. Andersson's proposal of an international regulation concerning a size limit of 50 cm. for salmon in the Baltic.

4. The Occurrence and Catch of Salmonids in the Latvian Coastal and Inland Waters.

by

W. Mannfeld.

The quantity of salmon and sea-trout (*Salmo salar* and *S. trutta trutta*) in Latvian waters amounts to about 140,000 kg yearly and the value to about 420,000 Latvian (gold) francs, of which about 70,000 kg to a value of about 210,000 Ls are caught by coast-fishing and the rest — by the fishing in inland waters.

The principal fishing places for salmon are as follows:

a. Sea-fishing.

a) The coast of the Latvian Soviet which borders on the Gulf of Riga near the Estonian frontier from the port of Ainaži to the fishing-village Kurmāle with a centre at Salacgrīva. In this place the salmonid-fishing is carried on mainly with big salmon-weirs, called "kurs" and "murds".

b) The coast of the Courland Gulf of the Baltic Sea from Kolka, the point flowing into the Gulf of Riga some 20 kilometres north-east of Ventspils, to the place at the mouth of the Užava-river, which is opposite to the north of the fishing-settlement Pelči. At the mouth of the Dzirnupe and in the west as far as Kuivoji, mainly the salmon-fishing in the west of the fishing-village and fishing-resort Šķēde near the mouth of the Ladupe and a more or less considerable fishing at the mouth of the Užava smaller salmon-weirs are employed as in Salacgrīva, while at all other places in this district only drag-nets are used.

Of great importance for the salmonid-fishing are the fishing settlements at the mouth of the Užava and Dzirnupe: Pāvilosta, Cīravlejas, Mērsrags, Jūrkalne, Engure, Ragaciems and Ķīļi. The quantity of salmon caught in these settlements amounting to about 80,000 kg yearly. At these places great numbers of salmon-smolts for a short time before entering the sea occur, as also before returning thereto; little has as yet been ascertained in the literature about the migrations of the smolts in the change of living conditions.

Attempts to introduce salmon-fishing with the line into the Gulf of Riga, which took place some 40—50 years ago near the mouth of the Daugava, and recently (1926—27) at Salace, were not successful.

c) Inconsiderable amounts of salmonids are caught with drag-nets at the northern cape of the west-coast of the Gulf of Riga, between the fishing-villages Roja and Melnsils.

d) The salmon-fishing-district Ventspils (Windau) has developed considerably; since 1926 successful attempts have been made to catch salmon with drag-nets and mainly with drift-nets (cf. Table I).

e) The salmon-fishing in the Liepaja (Libau) district, between Liepaja and Nida (near the Latvian-Lithuanian frontier) which is carried on mainly with the line, is quite considerable.

f) Alltogether a certain amount of salmon is yearly caught along the coast of Kurzeme (Courland) between the Lithuanian frontier and Kolkasrags (Domesnäs), while the salmon-fishing in the Gulf of Riga is carried on mainly at the mouths of the big rivers (Salace, Gauja and Daugava).

The results of salmonid-fishing (*Salmo salar* and *Salmo trutta*) in the coastal-districts mentioned were in 1924—27 as follows (according to the "Bulletin statistique des pêches maritimes de Lettonie", Volume I—IV, 1924—27):

Table I.

District	1924	1925	1926	1927	1924—27
a)	4,300	5,600	9,000	18,500	9,350
b)	60,200	56,300	56,800	62,300	58,900
c)	100	600	600	900	550
d)	—	—	3,400	4,800	4,100
e)	800	600	2,300	700	1,100
Remaining coast	200	400	600	700	475
Total quantity in kg	65,600	63,500	72,700	87,900	72,425
Total value	127,500	171,900	196,100	244,300	184,950
Average price	1.94	2.71	2.70	2.78	2.55

The following table which is based on the report of the Board of Fishery for the year 1926, furnishes data about the salmon-weels and drag-nets used for salmonid-fishing in Latvian waters.

Table II.

	District a	b	c	d	e	Remaining coast	Total	Total value in Lats
Fishing baskets	61	24	—	—	—	—	85	83,800
Drag-nets	—	28	4	3	2	—	37	72,315

b. Fishing in Inland Waters.

For the fishing of salmonids (*Salmo salar* and *Salmo trutta*) in Latvian inland waters only those rivers are of decisive importance at the mouths of which the above mentioned districts of coast-fishery are located, namely Salace, Daugava, Gauja, Roja, Venta, Bārta and their tributaries. In all these rivers fishing is carried on with salmon-garths and drag-nets.

The results of the salmonid-fishing can be only approximately estimated because no exact statistical data are available, consequently the figures below give only an approximate and relative picture.

Table III.

Systems of rivers	Salmo salar kg.	Salmo trutta kg.	Total of salmonid kg.
Salace	15,000	5,000	20,000
Gauja	2,000	16,000	18,000
Daugava	60,000	3,000	63,000
Venta	3,000	—	3,000
Bārta	1,000	—	1,000
Remaining rivers	2,000	3,000	5,000
	83,000	27,000	110,000

We see from the above that not only the *Salmo salar* migrates into the rivers flowing into the Gulf of Riga, but also the *Salmo trutta* (Lettish "taimiņš") which in the river Gauja represents even the bulk of salmonids migrating up and down. Also the west-coast of the Gulf of Riga is visited mainly by the *Salmo trutta.*

a) Salace (Salis). In Salace mainly the *Salmo salar* is caught, the *Salmo trutta* occuring in much smaller quantities. During the close-time (October 25th till December 31st.) some hundreds of salmon and sea-trout are caught every year in the sea and at the mouth of the Salace for the requirements of the salmonid-hatchery which is situated some 5 kilometres from the mouth of the Salace in Vec-Salace, and where salmonids are hatched artificially, carefully avoiding bastardization. Measurements of 83 salmoids, caught in the sea at the mouth of the Salace for hatching purposes in the spawning season of 1927, resulted in the following:

Salmo salar: 56 specimens, of which 36 female and 20 male; total length — 66—115 cm.; weight: 2.8—20.4 kg.

Salmo trutta: 27 specimens, of which 18 female and 9 male; total length: 47—79 cm.; weight: 0,8—5.2 kg.

b) Gauja (Livonian Aa). The Gauja is visited for spawning mainly by the *Salmo trutta*, which migrates up the river as far as Valmiera. Both kinds of salmonids are caught with fish-garths, both in the Gauja itself and in its tributaries Amata, Brasla, Rauna, Abula.

c) Daugava (Düna). The bulk of the Latvian salmon (*Salmon salar*) migrates up the Daugava and its tributaries on the right bank: Ogre, Perse, Aiviekste and

Dubna. In the Daugava the salmon migrates as far as Kraslava near the Russian frontier.

The fishing is carried on: at the mouth of the Daugava in general with drag-nets, but between the island Dole and Koknese and in the tributaries mainly with salmon-garths.

The size and weight of the salmon which visit the Daugava is shown by the following data relating to salmon, caught in 1924 in the Daugava between Dole and Koknese for the hatchery at Koknese during the close-time.

Salmo salar: 82 specimens, of which 57 female, and 25 male; length from 82 to 126 cm.; weight from 5.4 to 20 kg.

The Daugava salmon ("Dünalachs") attains a weight up to 30 kg.; salmon smaller than 80 cm and weighing less than 5 kg. are a rarity in the Daugava. The salmon starts migrating into the Daugava in the first week of May (St. George-salmon) but only in very small numbers; a more or less regular fishing begins about the 15th of June, but even till the 15th of July the results are still inconsiderable; they improve about the middle of August. The small fry returns into the sea before the river is finally frozen, i. e. not later than December.

Every year in spring large numbers of young salmon accumulate in the mouth of the Daugava, and in the sea between the Daugava and Gauja. Their length in spring (April) is usually not more than 10—15 cm., and they often get caught in the nets for small herrings; in autumn their size is 20—30 cm., and their weight 0.3—0.5 kg.

d) Venta (Windau). The fishing of salmon in the Venta is inconsiderable, but if carried on more intensively the results would doubtless be much better, as shown by the attempts made with drift-nets near the mouth of the river.

The Venta is visited for spawning mainly by the *Salmo salar;* the *Salmo trutta* migrating (according to G. Schneider) up this river only in small numbers and not farther than till Kuldiga (Goldingen), while the *Salmo salar* goes up the river as far as the Lithuanian frontier. In the Abava, a tributary of the Venta, the salmonids go up till Kandava, avoiding the brooks which feed this river.

An interesting way of catching salmon "in the air" has been introduced at Kuldiga, which is located on the Venta some 75 km. distant from its mouth. This river here develops a waterfall ("Rumba"), the hight of which is about 2.5 metres. In the river itself near the ledge of the fall, frames on three legs are placed, fitted with long sticks, at the ends of which fish-baskets of willow are fastened in such a way that they hang in the air just in front of the fall or with only their bottoms submerged. The salmonids migrating upstream, try to jump over the fall, but usually fail at the first attempt, and thus falling back, drop into the closely placed baskets, from which they are not able to escape.

e) Bārta (Bartan). The Bārta which flows through the lake "Liepajas ezers" into the sea is visited every year by a considerable number of *Salmo salar*, the greater part of which are caught before reaching the lake; nevertheless salmon are noticed in the river even near the Lithuanian frontier.

f) Other rivers. Besides the above mentioned, the salmonids migrate also up the following rivulets which fall into the sea:

A. Rivulets between the Salace and Daugava:
   1) Svētupe,
   2) Vītrupe,
   3) Age,
   4) Ķīšupe,
   5) Peterupe.

B. Rivulets between the Daugava and Kolkasrags:
   1) Lāčupe,
   2) Roja,
   3) Melsille.

C. Rivulets between the Kolkasrags and Venta:
   1) Pitragupe,
   2) Maz-Irbe,
   3) Irbe with its affluents Stende and Rinda.

D. Rivulets between the Venta and Bārta:
   1) Užava,
   2) Rīve,
   3) Saka with its affluents Durbe and Tabra.

In the following some short information is given about the artificial hatching of salmonids in Latvia:

There exist in Latvia at present three salmonid-hatcheries: in Vec-Salace, Koknese and Krāslava.

Besides the salmons destined for export, the following quantities of *Salmo salar* are hatched in the hatcheries mentioned and released into the rivers.

Table IV.

Year	Name of the rivers	Quantity	Yearly total
1923	Salace	219,000	219,000
1924	Daugava	340,000	
	Salace	266,000	
	Amata	168,000	774,000
1925	Daugava	35,000	
	Salace	44,000	79,000
1926	Salace	384,000	384,000
1923—26			1,456,000

The legal close-time for *Salmo salar* and *Salmo trutta* which lasts from October 25th till December 31st does not entirely correspond with the natural spawning-time of the salmonids: it starts too late, because every year already a fortnight earlier entirely spent specimens are caught; a corresponding alteration of the regulations regarding the close-time will shortly be enforced.

The legal size limit which for *Salmo salar* is 50 cm., and for *Salmo trutta* 35 cm., is quite adequate to the conditions in the Gulf of Riga, as has been proved by careful investigations. The fixing of an international size limit for both species lower than 35 cm. would be incompatible with Latvian conditions, taking into consideration the extended migrations of the salmonids.

5. Remarks on the Salmon and Sea-Trout off the Baltic Coats of Denmark

by

Erik M. Poulsen.

a. On the Danish salmon and sea-trout fisheries in the Western Baltic and the Baltic proper.

Both the salmon and the sea-trout are fished for off the Baltic coasts of Denmark. The importance of this fishery is found to increase the further we go in an easterly direction in these waters. The mean yield of these fisheries for the years 1920—1924 throughout the Baltic was distributed as follows:

	Western Baltic	Baltic coasts of Sealand, Møen, and Falster	Bornholm
Salmon	286 kg.	1,474 kg.	49,841 kg.
Sea-trout	33 -	912 -	3,333 -

The yield of the salmon and sea-trout fisheries thus increases greatly from west to east. The increase is however far greater in the case of the former than of the latter fishery. The reason for this marked increase in the yield is that the salmon and sea-trout only spawn to a very slight extent in the watercourses which flow into the western Baltic whilst many watercourses which teem with salmon and sea-trout flow into the Baltic proper. All the Danish watercourses flowing into the Baltic are very small and no salmon spawn in any of them. In the watercourses of Bornholm on the other hand and in one or two in the east and south of Sealand, spawning places for sea-trout are to be found. To some extent however a migration of sea-trout takes place to the Western Baltic from the watercourses which flow into the Kattegat and Belt Sea. A marked two-year-old sea-trout from Randers Fjord has thus been caught right down in Neustädter Bay[1]).

The salmon fishery in the Baltic is subjected to great annual fluctuations (see Tabel 1)[2]). In the worst years the yield may be right down at about 17,000 kg. whilst

[1]) A. C. Johansen og I. Chr. Løfting: Om Fiskebestanden og Fiskeriet i Gudenaaens nedre Løb og Randers Fjord. Skrifter udgivne af Kommissionen for Danmarks Fiskeri- og Havundersøgelser. No. 9. 1919.

[2]) According to the official Danish Fiskeri-Beretning.

Table 1. Yield in kgs. of the Danish Salmon and Sea-Trout Fisheries in the Western Baltic and the Baltic proper in the years 1911—1927.

Year	Salmon			Sea-Trout		
	Western Baltic[1])	Baltic proper		Western Baltic[1])	Baltic proper	
		East of Sealand, Møen and Falster	Round Bornholm		East of Sealand, Møen and Falster	Round Bornholm
1911.....	0	759	32,612	0	2.768	3,360
1912.....	0	475	32,811	0	900	5,886
1913.....	85	814	29,236	0	1,290	4,234
1914.....	0	1,027	29,047	50	3,555	5,994
1915.....	0	2,735	53,661	216	3,010	4,778
1916.....	31	1,177	22,253	0	1,906	5,620
1917.....	0	385	17,205	8	1,450	4,880
1918.....	143	1,945	15,228	0	800	4,280
1919.....	50	2,992	69,137	0	2,700	3,050
1920.....	765	1,716	81,247	95	610	3,980
1921.....	162	620	74,939	70	775	4,490
1922.....	170	2,095	39,577	0	2,210	2,698
1923.....	147	1,275	39,417	0	936	2,191
1924.....	188	1,662	14,027	0	29	3,305
1925.....	269	1,882	36,019	0	2,217	4,030
1926.....	674	175	45,767	250	7,604	6,365
1927.....	—	—	66,580	—	—	4,870

[1]) 0 means that the yield is so small that it has not been mentioned in the statistics.

in the best years it exceeds 80,000 kg. The yield of the sea-trout fishery may vary between 3000 kg. and 11,000 kg. No conformity to any law is revealed by the fluctuations, nor is there perhaps any probability for such, seeing that the stocks of salmon and sea-trout, on which the Danish fisheries are based, originate from rivers far distant from each other where the natural conditions differ so widely that good conditions for spawning and survival of the fry in one river area can easily be outweighed by bad conditions prevailing at the same time in other river areas. The yield of the fisheries in the years 1923—1926 has been about the same as it was in the years 1911—1914. In the years 1919—1921 the yield of the salmon fishery was especially great — about the double of the normal yield.

About four fifths of the combined yield of the salmon fishery in Danish waters is derived from the Bornholm waters. The sea-trout fishery off Bornholm is on the other hand of little importance in comparison with the fisheries in the Kattegat, Belt Sea, and Limfjord.

Fishing for salmon off Bornholm lasts from September and throughout the winter until May — in some years even to June.

In the autumn and in the winter until February, fishing is carried on with hooks in rather deep water outside the coastal zones proper. In the spring (from February) fishing is carried on chiefly with drift nets nearer the shore, and sometimes with gill

nets, which are put out in quite shallow water. Small salmon between 45 and 65 cm. in length are caught for the most part in gill nets. Fishing with drift nets and gill nets is carried on to all intents and purposes solely off the western, southern, and eastern coasts of Bornholm. In the summer the yield of the fishery is small.

The sea-trout fishery is carried on chiefly in the spring from February until about May and in the autumn in September, October, and November. In the winter and the summer the fishery is of very little importance. Trout are nearly always captured in shallow water close inshore and with gill nets. The nets are put out in such shallow water that they reach from the bottom to the surface. Trout are only seldom fished for more than two nautical miles from land, but in this case either with salmon hooks or salmon drift nets. The trout caught in this manner tend to be larger than those caught in the gill nets. It is quite probable that these large sea-trout originate from rivers in Sweden or Germany whilst those which are caught inshore by gill nets originate for the most part from rivulets in Bornholm.

b. On the protection of salmon and sea-trout in Danish waters.

1. Size limit.

For all Danish waters a size limit of 37 cm. total length is in force both for salmon and sea-trout. This size limit may be raised by special by-laws for particular areas, but this has not been done in the case of the Western Baltic nor the Baltic proper, nor the rivers and streams flowing into these waters.

The reason for the Danish size limit of 37 cm. having been fixed for both salmon and sea-trout is that if different size limits were instituted difficulties in the supervision and control would arise as a consequence of the difficulties in distinguishing the species. It has thus been thought that 37 cm. constituted a suitable compromise. The ideal size limit for salmon in the Baltic would be presumably about 50 cm., at which length they begin to ascend several rivers. But for the sea-trout this size limit would be too high. Many sea-trout attain sexual maturity for the first time at a lesser size. The Bornholm sea-trout begin to ascend the watercourses in order to spawn when they are about 30 cm. in length.

When therefore it is proposed to introduce an international size limit of 35 cm. for salmon and sea-trout in the Western Baltic and the Baltic proper, the Danish fishery is not directly affected since we already have a size limit which is 2 cm. higher, but by reason of the considerable salmon fisheries which are carried on off Bornholm by Danish fishermen where the salmon originate from rivers in the other Baltic countries, Denmark is greatly interested in an international size limit being instituted for salmon and sea-trout.

2. Close season.

Ripe salmon and sea-trout in breeding dress are protected throughout all the Danish waters including fresh waters from November 1st to December 31st. Silvery

salmon and trout on the other hand are not protected. The capture of protected fish may however be permitted by the Ministry of Agriculture when it can be proved that the fish are to be used for providing hatcheries with fecundated roe. This permission is made use of on a very large scale, but is only given on the condition that spawn corresponding to at least 20—50 per cent. of the roe obtained is placed in the watercourse or the waters from which the fish originated.

3. Protection afforded by various by-laws regulating the use of fishing gear.

Various restrictions on the use of fishing gears are intended partly to protect the sea-trout and salmon on their migrations up to the spawning places and partly to leave them in peace to some extent at the spawning places.

In order to hinder the capture of too many ascending fish closed areas have been instituted at the mouths of watercourses which the fish ascend. Fishing is prohibited within a stretch of 100—200 metres from the mouth, this distance varying according to the breadth of the watercourse. A free entrance is further secured for the fish from the sea into the closed area. Moreover it is forbidden to spread fixed fishing gear right across the watercourses. Fixed fishing gear may only be set out from the bank as far as the middle of the watercourse, and if it is set out from both banks at the same spot only two thirds of the width may be obstructed.

It is of very great importance to facilitate ascension for the ripe fish — so long as artificial hatching is not carried out on a larger scale than at present and better organized. — There are however no regulations determining how close nets may be placed to each other along the banks of the watercourses. Where the watercourses or the entrance to it permits nets etc. to be set out for great distances, fishing for the ascending fish becomes therefore often too intensive, so much so in fact that for all practical purposes the watercourse is completely obstructed. In a few cases however a special by-law fixes the maximum number of fishing gears permissible.

Where fixed fishing gears which obstruct the whole entrance are still to be found in consequence of ancient privileges they must be kept open from Saturday night to Monday morning.

The providing of salmon ladders can also be enjoined where dams or such completely bar the passage.

Finally there are regulations of various kinds in existence designed to prevent the pollution of watercourses.

c. Artificial propagation.

A considerable number of artificially hatched sea-trout fry is put into Danish watercourses which flow into the Baltic, and especially into those in Bornholm, which will be seen in the table below which gives the numbers of tiny fry thus liberated for the years 1920 to 1926, according to the Danish Fiskeri-Beretning.

	Bornholm	Baltic coasts of Sealand, Møen, and Falster
1920	560,000	35,000
1921	405,000	30,000
1922	725,000	32,000
1923	845,000	12,000
1924	352,000	9,000
1925	405,000	6,400
1926	400,000	7,000

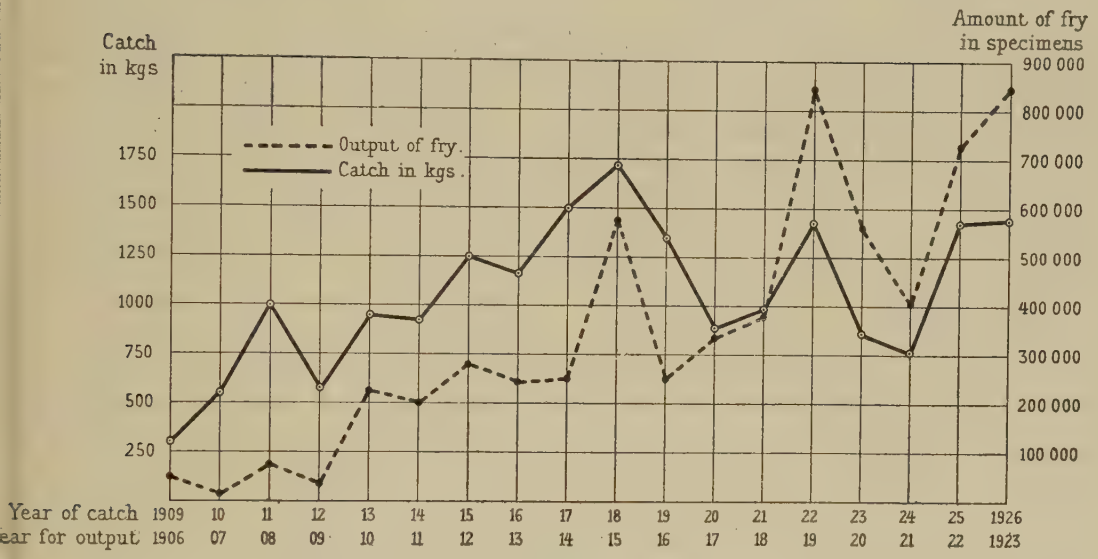

Fig. 1. Comparaison between output and catch of Sea-Trout 3 years after output in Bornholm rivulets.

There is only one hatchery in Sealand from which fry are placed in the watercourses flowing into the Baltic and only one in Bornholm. From one hatchery on the island Als sea-trout fry are put into rivulets to the Western Baltic. A certain number of sea-trout fry is put into the southernmost part of the Little Belt from two hatcheries in South Jutland.

Fry are liberated in practically every case when quite tiny; it is only rarely that they are liberated at the age of three months or more. This is in accordance with the theory that better results are usually obtained, when compared with the outlay involved, by liberating tiny fry than young fish[1]).

In placing artificially hatched fry into watercourses we have one of the best means of maintaining and even increasing the salmon stock in any waters of watercourse, and in such a way as not to involve any restrictions for the fishery as is the case when a size limit is imposed or other protective measures adopted. That the placing of artificially

[1]) A. C. Johansen and J. P. Jacobsen: On the Causes of the Fluctuations in the Yield of some of our Fisheries. I. The Salmon and Sea-Trout Fisheries. Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri. Vol. VI. No. 5. 1921.

hatched fry into watercourses has an appreciable effect on the fishery has been proved by the investigations of Dr. A. C. Johansen and Dr. J. P. Jacobsen in Randers Fjord and the Gudenaa on the sea-trout and salmon[1]). A close accordance was later shown to exist between the output of tiny sea-trout fry and the fishery yield in the Bornholm watercourses[2]). Fig. 1 shows graphically the connection between the output of fry in one year and the catch 3 years afterwards in three Bornholm rivulets. (It may be assumed and has been confirmed by age determination that the bulk of the sea-trout which are caught in Bornholm rivulets are $3^1/_2$ years old, and as liberation takes place in the spring and the catch in the autumn the difference to be reckoned with when making use of the statistics is 3 years). The curves plotted in the figure show that an increase in the number of fry liberated causes an increase in the yield. A calculation of the expenses incurred when the number of fry liberated was increased in the years 1910—1920 in comparison with the expenses incurred in the years 1906—1909 when only few fry were liberated shows that the extra expense for the years 1910—1920 did not amount to more than $^1/_3$ of the extra income of the fishery, and, it should be noticed, of the freshwater fishery alone.

A question which is of great interest as regards hatching is of course to what extent we can reckon that the liberated fry having been in the sea will return to the watercourse from which they set out. If we sum up the results of a series of marking experiments which have been carried out on salmon and sea-trout in Germany, Finland, Sweden, Norway, Scotland, and Denmark we find that out of 148 salmon that were recaptured after having been in the sea, 139 were recaptured in the same watercourse into which they were originally put, only 9 specimens being recaptured in other watercourses; out of 44 sea-trout which were recaptured after having been in the sea, 40 were recaptured in the watercourse into which they were originally put and 4 in other watercourses. When the fish ascend another watercourse the latter is usually the nearest to the watercourse from which the fish migrated.

There can be no doubt that the artificial hatching of salmon and sea-trout spawn has great advantages from an economic point of view. The technique of artificial hatching has been greatly improved through the knowledge gained by much experience, and as far as technique is concerned there is nothing to prevent as much spawn being hatched as may be desired, so that the Baltic could become very abundant in sea-trout and salmon. But can the necessary roe and milt be procured and can we continue to find the necessary places for the liberation and upgrowth of fry in their first years before they migrate? These are the two questions to which in the following years we must first and foremost devote our attention.

In the autumn of 1927 the catch of ripe sea-trout in the Belt Sea and the Baltic was fairly small and the hatcheries could not be furnished with as much roe as they were in a position to hatch. Also in the case of other Baltic countries (Sweden) it proved

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[1]) A. C. Johansen and J. P. Jacobsen: On the Causes of the Fluctuations in the Yield of some of our Fisheries. I. The Salmon and Sea-Trout Fisheries. Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri. Vol. VI. No. 5. 1921.

[2]) Erik M. Poulsen: Om Virkningen af Udsættelsen af Ørredyngel i bornholmske Aaer. Dansk Fiskeritidende, 1925.

difficult to provide a sufficient number of ripe fish for furnishing the hatcheries with roe. A stronger organization of the hatcheries in the different countries together with an organized interchange of eyed eggs between one freshwater area and another would certainly to some extent remedy the lack of ripe parent fish.

Another question of interest as regards artificial hatching is the procuring of rapid-growing parent fish. The growth of sea-trout is different for different waters. There are waters — as in Bornholm — where the growth is less, and waters — such as the Gudenaa — where the growth is greater. The Bornholm sea-trout grows during its first summer in the sea about 10—12 cm. and in the second summer about the same, attaining by the end of it a length of about 40—43 cm. In the Gudenaa the sea-trout, according to A. C. Johansen, grows about 20 cm. during its first summer in the sea, and about 16 cm. in the second summer attaining by the end of it an average length of about 56 cm. No investigations have been as yet carried out to show how far these differences in growth are the results of heredity, or whether external conditions are here the sole determining factor. Some interesting experiments relating to the growth of salmon in fresh water in the north of Sweden[1]) have shown that fry of the same race grow more rapidly in ponds in the south of Sweden (where the summers are longer) than in ponds in the north of Sweden (where the summers are shorter). These experiments thus show that the growth of salmon is dependent on the length of the summer, but they do not show definitely whether the rate of growth is dependent merely on external conditions or whether it is also determined by heredity. We still need investigations to show whether salmon and sea-trout from a watercourse where they grow rapidly will lose this rapid growth if they are transplanted to a watercourse where the indigenous fish grow slowly.

The third question of interest as regards hatching is whether we shall always have sufficient watercourses for the output and upgrowth of fry. The increasing industrialization of watercourses constitutes a considerable peril in this connection, not so much owing to the destruction of the nurseries, since they as a rule are situated high up the watercourses whilst industrial undertakings lie as a rule nearer the mouth, as on account of the fact that the young fish are thereby deprived of access to the sea by dams or by an excessive pollution of the lower reaches of the watercourse. In order to put a stop to this in future close co-operation will be needed between the biologists and the chemists. Pollution is a much greater danger for the salmon stock than for the sea-trout stock, the salmon requiring as a rule greater watercourses than the sea-trout, and the greater watercourses are more suitable for industrialization than the lesser ones.

Practically no salmon fry have been put in recent years into the Danish watercourses which flow into the Baltic and the Transition Area. Since the Gudenaa has become partly ruined as waters for salmon by industrial undertakings, attention has been focussed on the hatching of sea-trout which thrive admirably in the many small rivulets which flow into the Baltic and the Belt Sea. It is difficult for Denmark to furnish watercourses flowing into the Baltic with salmon fry, but natural conditions permit on the other hand

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[1]) Osc. Nordqvist and Gunnar Alm: Uppfödning av Laxyngel. Medd. från Kungl. Lantbruksstyrelsen. No. 262. Stockholm 1927.

a considerable quantity of sea-trout fry to be hatched in the Danish watercourses flowing into the Baltic, and these watercourses can moreover easily be stocked with artificially hatched sea-trout fry.

Co-operation between the different Baltic states will render it possible to stock the Baltic abundantly with salmon and sea-trout. The institution of an international size limit for salmon and sea-trout in the Baltic is a very important condition for the setting on foot of such co-operation.

6. Remarks relative to the question of the Salmon and Sea-trout Fishery in Poland.

By

Prof. **M. Siedlecki.**

Two species of Salmons occur in Polish rivers: The true Salmon (*Trutta salar*) called in Polish "Losoś" and the Sea-trout (*Trutta trutta*) called "Troć". Specimens with well marked characters of both species are to be found in the Vistula and some affluent rivers but a great percentage of other specimens present serious difficulties to the exact determination. In spite of the works or reports of many authors the systematic position of the "Vistula-Salmon" has up till now not been definitely settled. Opinions were advanced that the Vistula-Salmon belongs to a special race or that besides the pure races of both species, hybrids are to be found, and not only hybrids between two species of salmon but also between the salmon and fresh water trout. The last opinion seems to be not improbable in view of the fact, that sometimes in certain hatcheries not much attention was paid to the choice of pure bred specimens used for the artificial fertilisation of salmon-eggs. New investigations and especially racial-studies of the Vistula-Salmon are still necessary and are now carried on by several Polish specialists. In the present report, we shall use the word "Salmon" as referring to both species.

Salmon occurs in Poland in the system of the Vistula, with some of its affluents and also in the small river Reda[1]). The spawning places of salmons in the small river Reda are distant only some kilometers from the mouth of the rivulet discharging its waters directly into the Golf of Puck. In the system of the Vistula the main spawning places are situated in two rivers: Dunajec and Skawa. The last named spawning places are about 1000 kilometers distant from the estuary of the Vistula.

The spawning in the Skawa occurs in the last autumn months, some weeks later than the period of spawning in the Dunajec. It is not improbable that in the Skawa are situated the spawning places of true salmon (*T. salar*) and in the Dunajec the spawning places for the sea-trout. This part of the Dunajec where the main spawning places are situated is rented by the Polish Angling Sport Club; the part of the Skawa with the spawning places is farmed by an association of fishermen. The close time for both

[1]) See Fig. 1.

species of salmons is from September 1st till December 31st in that part of Poland where the spawning places are situated. The minimum size of market-fish is fixed at 50 cm. for the salmon from the river in the highest part of the Vistula and its affluents coming from the Carpathian Mountains. In the lower parts, near the mouth of the same river the minimum size is 35 cm. and the same size limit is now obligatory for the market fish caught near the Polish coast.

Fig. 1. Situation of Vistula in Poland. Only Rivers important for Salmon are given. Skawa—Dunajec—Brda—Reda. Salmon hatcheries: One near Dunajec—River, two near Brda, one near Reda—River. Other hatcheries not marked.

Good fishing grounds for the salmon in the sea are situated close to the Polish coast or not very far from it. The small map (Fig. 2) shows the fishing ground and also the distribution of different methods of fishing the salmon in different parts of the territorial waters and in their neighbourhood.

The period of fishing for the salmon begins in October and lasts ordinarily till the end of May. As fishing-gear are used fixed and drift nets, angling tackle and also large trawls handled from the shore. Large driftnets, called "Plawnica" and angling tackle ("Takla") give the best results and are used chiefly for the large salmon; the young salmon called "mielnica" by the fishermen is taken by the means of the large trawls, called "laskorn", by means of fixed nets and sometimes by a special kind of driftnet.

The large driftnets (plawnica) have meshes of about *90* mm.; large specimens only can be caught by this gear. Driftnets used sometimes for the catch of small salmon ("mielnica") have smaller meshes (about 40 mm.) but they are used very seldom and do not give good results. The angling tackle of very particular construction give sometimes

very good results. They are put out in deep water, sometimes 20 to 30 miles from the shore, always in large numbers.

Poor results are in general obtained by the large trawl handled from the shore (laskorn). Only sometimes, and under special conditions, are larger quantities of salmon caught by this method. The meshes of the trawl are *75* to *50* mm. wide.

The fishery by means of the larger trawls and also of the fixed nets is practised chiefly by the poorer fishermen.

The general results obtained by all these fishing methods are very different in different years. The fishermen suppose that there is a certain periodicity in the succession of good and bad "salmon years" and assert that a ten year period usually occurs between two "good years". It has not been possible up to now to establish the existence of such a periodicity.

From 1921 the annual catch of salmon on the Polish coast was subjected to very characteristic fluctuations. (See Fig. 3).

The fishery in 1921 was very poor with a total result of 43,700 kg. But suddenly in the next year 1922 the catch was about five times as large as in the previous year and amounted to 226,000 kg. This extraordinary increase was partly due to the increase of the number of motorboats used by fishermen immediately after the war with the Bolscheviks. The number of motorboats which was 61 in 1921 was augmented to 83 in 1922, i. e. by about 30 per cent. Certainly the year 1922 was also a "good salmon year" as the fisherman calls it, the large catch in this year can be considered as exceptional and was perhaps due to some

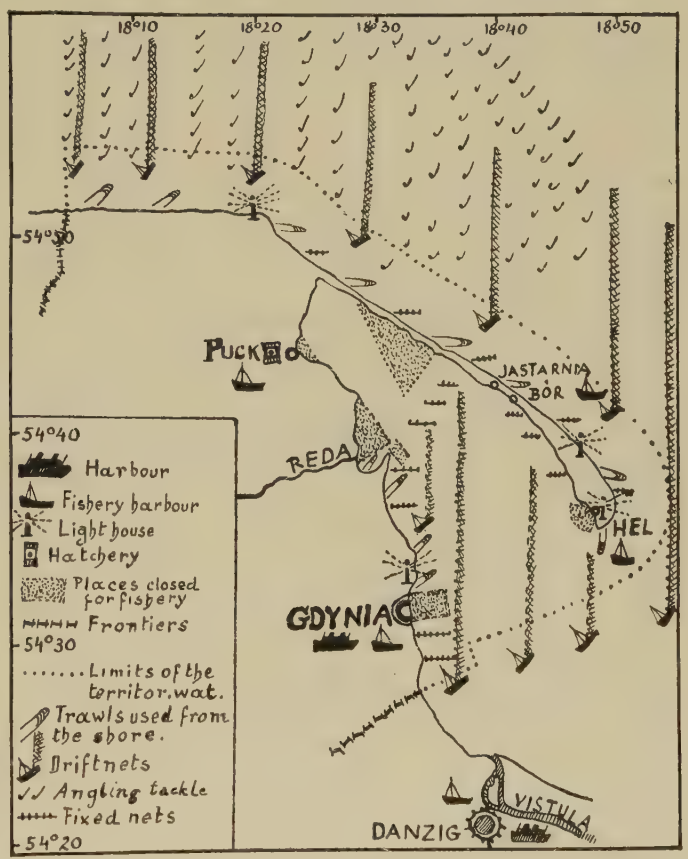

Fig. 2. Salmon-Fishery on the Polish coast. The marks for different fishing gear are placed on respective fishing grounds.

The Salmon Fishery on the Polish coast 1921—1926. In Kgms.

1921	1922	1923	1924	1925	1926
43,700	226,000	48,500	71,600	32,300	97,500

extent to the general improvement in the conditions of the fishery in the Baltic Sea, as was pointed out by O. Pettersson.

After this exceptionally good year all the next four years show a rapid decrease in the results of the salmon fishery and a period of three bad years follows. A small increase in 1926 brings the catches to about 40 per cent. of the results in the good year. In 1927 further increase is observed, but not such a great one, as in 1922.

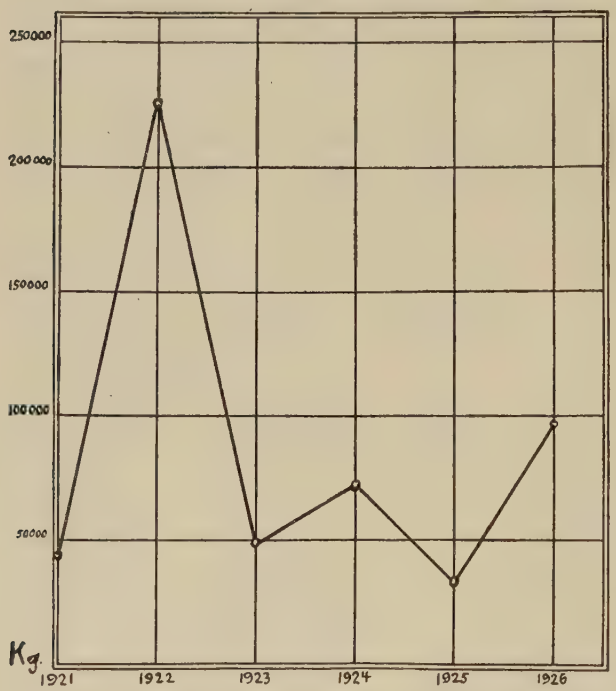

Fig. 3. The annual catch of Salmon on the Polish coast.

It is obvious that the salmon fishery in general, shows in the last years on the Polish coast a very marked decrease. This situation is the more striking considering that the number of motor-boats increased from 61 to 92 in the same period and that there was in general an intensive fishery.

Another fact is also very remarkable. The specimens of salmons caught near the spawning places for the purposes of the hatcheries were in last year considerably smaller than in previous years. Ripe specimens of about 2—3 kg. were found very often; in previous years the spawning salmons were of about 8—10 kg. in weight.

It seems therefore probable that the character of the population of salmon near the Polish coast and in the Vistula is now subjected to change. The nature of this change is to be studied as regards the quantity and the racial characters of the Vistula-Salmon. It is also obvious that measures concerning the protection of salmon should be introduced.

In the Polish territorial waters the salmon seems to be sufficiently protected. The dimensions of meshes in the nets used for the fishery are so large (see above) that only large specimens can be caught by means of the fishing gear made according to governmental instructions. It is of course obvious that the control of the fishing gear can only be succesful in the territorial waters. Near the Polish coast the territorial waters are only 3 miles wide, but the best salmon fishing grounds are situated further into the open sea, sometimes 10 or 20 miles from the shore (see Fig. 2). The question may be raised whether it would not be advisable, for this special purpose i. e. for the control of the fishing gear to enlarge the limits of the territorial waters to an extent of 5 or 6 miles from the shore. The control of the dimensions of the market fish alone, without any control of the methods of fishing cannot be regarded as sufficient,

especially in Polish waters, because many of the fishermen returning from the fishing grounds can easily avoid any control on the shore in the small localities of Poland or especially in the large port of Danzig, the main fishmarket in this part of the Baltic.

In general the quantity of young salmon caught on the Polish coast is not considerable. The figures for the 3 years 1922—24 are very instructive in this respect. Figures are in kilograms.

Year	Young Salmon "Mielnica"	Large Salmon	Percentage of the young Salmon in the total catch
1922.....	67,500	158,500	29
1923.....	4,200	35,500	13
1924.....	4,200	67,300	6

In the exceptionally good year 1922 the considerable increase in the total catch was due to the larger specimens and in bad years also the decrease in the number of large specimens caused the bad general result. The catches of young salmons seem therefore to play a subordinate rôle in the fishery on the Polish coast and this fishery cannot have any serious repercussion on the salmon fishery in the Baltic in general.

The idea of protecting the salmon by means of the introduction of a larger size limit than it is enforced nowadays seems to be of no practical value for the Polish coast. The size limit is (see above) fixed at *35* cm. in the sea and in the lower parts of the Vistula; a minimum of 50 cm. has been in force for 2 years, in the upper part of this river.

The salmon of 35 cm. are caught chiefly by poor fishermen, and not in considerable quantity. Further restrictions would injure this population too much and would not alter the present state of things to any great extent, especially in view of the fact that the control of fishing gear on the fishing grounds outside the territorial waters is practically impossible.

The decrease in the population of salmon in the Baltic must be considered also from another point of view. Measures should be introduced to increase the population by intensive artificial breeding and by the protection of natural spawning places.

Many years ago very much attention was paid to the question of the artificial propagation of the salmon in the Vistula. The Society for Fishery in Kraków, working chiefly in the southern part of Poland began to put large quantities of small, young salmon in the Vistula about fifty years ago. Six years ago the hatcheries belonging to governmental institutions and to the Angling Sport Club in Kraków put every year about one million salmon fry and several thousands of larger young salmons (Fingerlinge) into the Vistula or the affluents of this river. The mouth of the Vistula is situated in the territory of the free town of Danzig; therefore to establish the fact that the young fishes really arrive at the sea is very difficult for Polish scientists. In spite of this difficulty it is to be supposed that every year a considerable percentage of the young fishes reaches the Baltic sea.

No attempt was made to put salmon fry into the river Reda, but it is intended in the next years to begin similar operations in this river as in the Vistula. Preliminary

investigations for this purpose have been already carried out by the Department for the Organisation of Fisheries in the Institute for Scientific Agriculture at Bydgoszcz.

It seems advisable to encourage the respective governments of the different countries to develop artificial propagation of salmon in the rivers.

Besides artificial propagation much attention must be paid to the protection of natural spawning places in the rivers. In Poland the main spawning places of the salmon are situated very far from the coast. In the Reda they are situated some kilometers only from the mouth of this rivulet. In the system of the Vistula (see Fig. 1) they are about 1,000 kilometers distant from the sea, chiefly in the river Dunajec, far in the Carpathian Mountains and in some places on the very frontier between Poland and Tschecoslovakia. A preliminary accord between these two States concerning the question of the protection of spawning places in the rivers on the frontier has already been signed. Both States are now obliged to introduce similar laws and measures for the efficient protection of the fishery and especially of the spawning places.

No less important than the protection of the spawning places is the protection of the estuaries in order to facilitate the entrance of the salmon going up to the rivers for spawning.

In this respect Poland is in a very particular position, because the estuary of the Vistula is situated on the territory of the Free Town of Danzig. It is not possible for the writer of these lines to furnish any exact detail concerning the question of the fishery near the mouth of the Vistula. Some personal observations seem to indicate that salmon fishery is carried on in the sea not far from the Vistula estuary.

The mouth of the rivulet Reda has up till now not been sufficiently protected, but it is intended to introduce some new laws prohibiting salmon fishing in this place during the period when these fish enter this rivulet.

It is obvious that nowadays the protection of salmon in the estuaries on and near the Polish coast is insufficient. The writer of these lines is persuaded that an international accord prohibiting salmon fishing in estuaries and at a distance of at least one or two miles from the estuary during the period when the fish enter the rivers, would be not only advisable but also very practical.

A close investigation into the natural history of the salmon must provide the basis for the proposed protection which is designed to increase its population. The Polish Government and Polish scientists began many years ago the study of the "Vistula-Salmon". In recent years this investigation has been carried out in several directions. A careful study of the salmon in the Vistula and its affluents is being made by the scientists investigating, for the purpose of racial studies, salmon used in hatcheries for artificial propagation.

Marking experiments have been carried on for three years by the Department for Fishery in the Institute of Scientific Agriculture at Bydgoszcz. Several thousands of young salmon, about 14 cm. in length, marked with silver marks were put into the Vistula. A reward of 15 złotys (about 7 shillings) is granted the fisherman who brings a marked fish. (The marked fish itself is purchased at the day's price.) The Marine Fisheries Laboratory at Hel is the central point where the fishermen obtain the reward.

In order to cast some light on the question, whether the hybrids between the salmon and the trout are of economic value and what the difference is between them and the pure bred salmon, experiments are carried on in the hatchery on the Dunajec. The first series of experiments consists in the study of the hybrids between *Trutta fario* and *Trutta trutta.* It is intended to breed these hybrids to the size of about 14 cm. in special ponds and to put them, after marking, into the Vistula or directly into the sea.

Other biological experiments and studies concerning the natural conditions of the life of the salmon are also carried on. It is intended, by means of all these studies to approach nearer to the solution of the question of the race and habits of the Vistula salmon. —

Practical hints concerning the question of the salmon in the Baltic near the Polish coast may be derived as a conclusion from the foregoing report.

1) The size limit, fixed at 35 cm. is sufficient and there is no need to introduce a higher size limit.
2) An international agreement to prohibit salmon fishing near the estuaries of the rivers would be of the greatest value.
3) In order to make efficient the control of the fishery and of the fishing gear, an international accord enlarging the limits of the territorial waters to five or six miles from the shore (but only for the purpose of controlling the fishery) would be practical and advisable.
4) The protection of natural spawning places and the development of the artificial propagation of the salmon should be recommended to the respective Governments.
5) Biological studies of the races and the hybrids of salmonids and also marking experiments on the salmon should be recommended.